

<b>AWARD/CONTRACT</b>		1. THIS CONTRACT IS A RATED ORDER UNDER DPAS (15CFR350)	RATING DO-C9	PAGE OF PAGES 1
2. CONTRACT NO. (Proc. Inst. Ident.) NO <b>NNJ06TA25C</b>		3. EFFECTIVE DATE <i>Sept. 8, 2006</i>	4. REQUISITION/PURCHASE REQUEST/PROJECT NO <i>4200172686 &amp; 4200172684</i>	
5. ISSUED BY: CODE NASA/Johnson Space Center 2101 NASA Parkway Mail Code: BT Houston TX 77058		6. ADMINISTERED BY (If other than item 5) CODE		
7. NAME AND ADDRESS OF CONTRACTOR (No., street, city, county, State and ZIP Code) Lockheed Martin Corporation P.O. Box 179 Mail Stop L3008 Denver, Colorado 80201		<div style="border: 2px solid black; padding: 5px; text-align: center;"> <b>APPROVED</b>  <i>[Signature]</i>  <b>JSC PROCUREMENT OFFICER</b>  <i>8/31/06</i>  <b>DATE</b> </div>		
DUNS: 926784042		DELIVERY <input type="checkbox"/> FOB ORIGIN <input checked="" type="checkbox"/> OTHER (See below) DISCOUNT FOR PROMPT PAYMENT		
CODE 04236		FACILITY CODE		
11. SHIP TO/MARK FOR CODE		12. PAYMENT WILL BE MADE BY: CODE		
13. AUTHORITY FOR USING OTHER THAN FULL AND OPEN COMPETITION <input type="checkbox"/> 10 U.S.C. 2304(c) ( ) <input type="checkbox"/> 41 U.S.C. 253(c) ( )		14. ACCOUNTING AND APPROPRIATION DATA		
15A. ITEM NO.	15B. SUPPLIES/SERVICES	15C. QUANTITY	15D. UNIT	15E. UNIT PRICE
1	CEV - See attached Statement of Work	1	*	*
15G. TOTAL AMOUNT OF CONTRACT				*Refer to Schedule A, Clause B.3

N	SEC.	DESCRIPTION	PAGE(S)	N	SEC.	DESCRIPTION	PAGE(S)
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x	B	SUPPLIES OR SERVICES AND PRICES/COSTS		PART III - LIST OF DOCUMENTS, EXHIBITS AND OTHER ATTACH.			
x	C	DESCRIPTIONS/SPECS./WORK STATEMENTS		x	J	LIST OF ATTACHMENTS	
x	D	PACKAGING AND MARKING		PART IV - REPRESENTATIONS AND INSTRUCTIONS			
x	E	INSPECTION AND ACCEPTANCE			K	REPRESENTATIONS, CERTIFICATIONS AND OTHER STATEMENTS OF OFFERORS	
x	F	DELIVERIES OR PERFORMANCE			L	INSTRS. CONDS. AND NOTICES TO OFFERORS	
x	G	CONTRACT ADMINISTRATION DATA			M	EVALUATION FACTORS FOR AWARD	
x	H	SPECIAL CONTRACT REQUIREMENTS					

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### CONTRACTING OFFICER WILL COMPLETE ITEM 17 OR 18 AS APPLICABLE

17. <input checked="" type="checkbox"/> CONTRACTOR'S NEGOTIATED AGREEMENT (Contractor is required to sign this document and return 3 copies to issuing office.) Contractor agrees to furnish and deliver all items or perform all the services set forth or otherwise identified above and on any continuation sheets for the consideration stated herein. The rights and obligations of the parties to this contract shall be subject to and governed by the following documents: (a) this award/contract, (b) the solicitation, if any and (c) such provisions, representations, certifications, and specifications, as are attached or incorporated by reference herein. (Attachments are listed herein.)		18. <input type="checkbox"/> AWARD (Contractor is not required to sign this document.) Your offer on Solicitation Number _____, including the additions or changes made by you which additions or changes are set forth in full above is hereby accepted as to the items listed above and on any continuation sheets. This award consummates the contract which consists of the following documents: (a) the Government's solicitation and your offer and (b) this award/contract. No further contractual document is necessary.	
19A. NAME AND TITLE OF SIGNER (Type or print) <b>James B. Blackwell Manager, Contracts</b> <b>LOCKHEED MARTIN CORPORATION</b>		20A. NAME OF CONTRACTING OFFICER <i>K. Lee Page</i>	
19B. NAME OF CONTRACTOR <b>LOCKHEED MARTIN CORPORATION</b>		20B. UNITED STATES OF AMERICA	
19C. DATE SIGNED <i>[Signature]</i> July 26 2006		20C. DATE SIGNED <i>[Signature]</i> 31 Aug 2006	

NSN 7540-01-152-8069

PREVIOUS EDITION UNUSABLE

26-107

STANDARD FORM 26 (REV 4-85)  
 Prescribed By GSA  
 FAR (48 CFR) 53.214(a)

**SECTION A**  
**OMB Approval 2700-0042**

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**AWARD/CONTRACT FORM**

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(END OF SECTION)

**PART I - THE SCHEDULE**

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**SECTION B - SUPPLIES OR SERVICES AND PRICE/COSTS**

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**B.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

**I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

**II. NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

(End of By Reference Section)

**B.2 DESCRIPTION OF WORK**

The Contractor shall, in a manner consistent with and subject to the terms and conditions hereof, furnish all resources necessary except as otherwise provided in this contract, to design, develop, test, evaluate and produce Crew Exploration Vehicle (CEV) variants that will carry human crews from Earth into space and back again. Coupled with transfer stages, landing vehicles, and surface exploration systems, the CEV will serve as an essential component of the architecture that supports human voyages to ISS, the Moon, and beyond.

This contract is divided into three separate contract schedules (A, B, and C). Terms and conditions set forth in each contract schedule apply to that schedule only.

(End of clause)

**B.3 ESTIMATED COST AND AWARD FEE (NFS 1852.216-85) (SEP 1993)**

a. The estimated cost and award fee for Schedule A (*base fee not applicable*) of this contract is broken out as follows:

	<u>Estimated Cost</u>	<u>Maximum Award Fee</u>	<u>Total Cost and Award Fee</u>
Completion form work (all work not identified as IDIQ)			\$3,885,932,174
IDIQ Delivery Orders Issued**		\$0	\$0
Total		\$*	\$*

***\* to be filled in by NASA***

\*\* NOTE: Work subject to IDIQ provisions and separately identified in the statement of work. Amounts for estimated cost and available award fee for cost reimbursable IDIQ delivery orders issued will be periodically updated unilaterally as these IDIQ delivery orders are issued/amended. There may be some discrepancy with the total amount for the IDIQ task/delivery orders issued listed in this clause and the total amount for cost reimbursable IDIQ delivery orders that have been issued during intervals between periodic updates of this clause. The IDIQ value shown here identifies the current authorized work. The maximum potential IDIQ contract value is identified in Clause I.7 ORDER LIMITATIONS.

(End of clause)

**B.4 CONTRACT FUNDING (NASA 1852.232-81) (JUN 1990)**

- a. For purposes of payment of cost, exclusive of fee, in accordance with the Limitation of Funds clause in Section I, the total amount allotted by the Government Schedule A is an estimate for the period of performance *TBD by NASA at Award*.
- b. Schedule A contract funding summary:

	COST	FEE	TOTAL
Schedule A			\$27,000,000

(End of clause)

**B.5 MINIMUM/MAXIMUM IDIQ POTENTIAL CONTRACT VALUE**

In accordance with I.8 INDEFINITE QUANTITY (b), the guaranteed minimum amount of work which may be required under this contract Schedule A is *\$120,000* and the maximum amount of work which may be required under this contract is *\$750,000,000*. This amount includes both cost and fee. The maximum amount is an estimate and does not reflect an obligation of the Government. The Government's obligation hereunder shall be based on that specified in the delivery orders issued during the period of the contract.

(End of clause)

**B.6 RATE TABLE FOR PRICING TASK ORDERS**

***Completed Rate Tables for Schedule A are included as Attachment J-23.***

The purpose of this clause is to set forth the direct, indirect, and fee rates to be utilized in the subsequent negotiation and cost establishment of ID/IQ Task Orders in accordance with Task Ordering Procedure. The contractor will utilize the direct, indirect and fee rates established herein to determine the estimated costs for each ID/IQ Task Order. The following form is to be filled out for each of contract years.

(End of clause)

(END OF SECTION)

## **SECTION C - DESCRIPTION/SPECIFICATION/WORK STATEMENT**

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The Contractor shall, in manner consistent with and subject to the terms and conditions hereof, furnish all resources necessary to provide the effort described in Attachment J-1, Schedule A – Statement of Work.

(END OF SECTION)

**SECTION D - PACKAGING AND MARKING**

**D.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

**I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

**II. NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

(End of By Reference Section)

**D.2 PACKAGING, HANDLING, AND TRANSPORTATION (NASA 1852.211-70) (SEP 2005)**

- (a) The Contractor shall comply with NASA Procedural Requirements (NPR) 6000.1, "Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components", as may be supplemented by the statement of work or specifications of this contract, for all items designated as Class I, II, or III.
- (b) The Contractor's packaging, handling, and transportation procedures may be used, in whole or in part, subject to the written approval of the Contracting Officer, provided (1) the Contractor's procedures are not in conflict with any requirements of this contract, and (2) the requirements of this contract shall take precedence in the event of any conflict with the Contractor's procedures.
- (c) The Contractor must place the requirements of this clause in all subcontracts for items that will become components of deliverable Class I, II, or III items.

(End of clause)

(END OF SECTION)



## **SECTION E - INSPECTION AND ACCEPTANCE**

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### **E.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

#### **I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
52.246-3	MAY 2001	INSPECTION OF SUPPLIES - COST REIMBURSEMENT
52.246-8	MAY 2001	INSPECTION OF RESEARCH AND DEVELOPMENT-COST-REIMBURSEMENT

#### **II. NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
1852.246-73	MAR 1997	HUMAN SPACE FLIGHT ITEM

(End of By Reference Section)

### **E.2 HIGHER-LEVEL CONTRACT QUALITY REQUIREMENT (FAR 52.246-11) (FEB 1999)**

The Contractor shall comply with the higher-level quality standard selected below:

SAE AS9100, Quality Systems-Aerospace, model for Quality Assurance in Design, Development, Production, Installation and Servicing

(End of clause)

### **E.3 MATERIAL INSPECTION AND RECEIVING REPORT (NFS 1852.246-72) (AUG 2003)**

- (a) At the time of each delivery to the Government under this contract, the Contractor shall furnish a Material Inspection and Receiving Report (DD Form 250 series) prepared in six (including original) copies, an original and five copies.
- (b) The Contractor shall prepare the DD Form 250 in accordance with NASA FAR Supplement 1846.6 . The Contractor shall enclose the copies of the DD Form 250 in the package or seal them in a waterproof envelope, which shall be securely attached to the exterior of the package in the most protected location.

- (c) When more than one package is involved in a shipment, the Contractor shall list on the DD Form 250, as additional information, the quantity of packages and the package numbers. The Contractor shall forward the DD Form 250 with the lowest numbered package of the shipment and print the words "CONTAINS DD FORM 250" on the package.

(End of clause)

**E.4 PRELIMINARY INSPECTION AT SOURCE AND FINAL INSPECTION AND ACCEPTANCE AT DESTINATION (JSC 52.246-91) (JUN 1991)**

Preliminary inspection for compliance with the contract specifications and requirements may be performed at origin by an authorized representative of the Government, and final inspection and acceptance will be performed by the contracting officer or his/her authorized representative at the destination.

(End of clause)

(END OF SECTION)

## **SECTION F - DELIVERIES OR PERFORMANCE**

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### **F.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

#### **I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
52.242-15	AUG 1989	STOP-WORK ORDER (ALT I) (APR 1984)
52.247-29	FEB 2006	F.O.B. ORIGIN

#### **II. NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

(End of By Reference Section)

### **F.2 COMPLETION OF WORK (JSC 52.211-95) (OCT 2001)**

All work required under this contract in Schedule A, including submission of all reports, shall be completed on or before:

- a) Design, Develop, Test and Evaluation--- Per the Integrated Project Schedule (Attachment J-16)
- b) IDIQ--- refer to IDIQ clauses "Ordering" and "Indefinite Quantity" in Section I

(End of clause)

### **F.3 BILLS OF LADING (NFS 1852.247-73) (JUN 2002)**

The purpose of this clause is to define when a commercial bill of lading or a government bill of lading is to be used when shipments of deliverable items under this contract are Free On Board (F.O.B.) origin.

- (a) Commercial Bills of Lading. All domestic shipments shall be made via commercial bills of lading (CBLs). The Contractor shall prepay domestic transportation charges. The Government shall reimburse the Contractor for these charges if they are added to the invoice as a separate line item supported by the paid freight receipts. If paid receipts in support of the invoice are not obtainable, a statement as described below must be completed, signed by an authorized company representative, and attached to the invoice. "I certify that the shipments identified below have been made,

transportation charges have been paid by (company name), and paid freight or comparable receipts are not obtainable.

Contract or Order Number: NNJ06TA25C  
Destination: TBD.”

(b) Government Bills of Lading.

- (1) International (export) and domestic overseas shipments of items deliverable under this contract shall be made by Government Bills of Lading (GBLs). As used in this clause, “domestic overseas” means non-continental United States, i.e. Hawaii, Commonwealth of Puerto Rico, and possessions of the United States.
- (2) At least 15 days before shipment, the Contractor shall request in writing GBLs from: Cindy Ratliff, Lead TMS, Contract Transportation, 2101 NASA Parkway, Mail Code JB7, Houston, TX, 77058. If time is limited, requests may be by telephone: 281-483-3208. Requests for GBLs shall include the following information.
  - (i) Item identification/ description.
  - (ii) Origin and destination.
  - (iii) Individual and total weights.
  - (iv) Dimensional Weight.
  - (v) Dimensions and total cubic footage.
  - (vi) Total number of pieces.
  - (vii) Total dollar value.
  - (viii) Other pertinent data.

(End of clause)

**F.4 FLIGHT ITEM (JSC 52.247-95) (SEP 1989)**

Block 16 of each Department of Defense Form 250 prepared for hardware or equipment to be shipped under this contract must be annotated as follows in ¼-inch letters or larger by hand printing or rubber stamp:

THIS IS A FLIGHT ITEM: OR “THIS IS MISSION ESSENTIAL GROUND SUPPORT EQUIPMENT,” as applicable.

(End of clause)

**F.5 SHIPPING INSTRUCTIONS**

All documentation and hardware to be shipped to JSC shall be shipped as identified below:

Parcel Post Shipments and Freight Shipments  
Ship to: Transportation Officer,  
Building 421  
NASA Johnson Space Center

2101 NASA Parkway  
Houston, TX 77058-3696  
Mark for: Accountable Property Officer  
Mark With: Contract Number NNJ06TA25C  
For reissue to: (Name) Fred Ouellette  
(Mail Code) ZV  
(Bldg.) 17  
(Rm.) 252F

Hardware may be required to be shipped to locations other than those identified above in the performance of this contract; the “ship to; mark for; for reissue to” information shall be modified as necessary to annotate the appropriate information for each shipment.

(End of clause)

#### **F.6 DELIVERABLES**

The Contractor shall make all deliverables as described in Section C, Attachment J-9, Deliverable Items List, and Attachment J-2, Data Requirements Description, of this contract.

(End of clause)

#### **F.7 OPTION TO EXTEND ORDERING PERIOD**

The Contracting Officer may exercise each of the options listed below by issuance of a unilateral contract modification 30 days or more before the end of the period set forth in clause F.2 (b) “Completion of Work”. Should the option(s) be exercised, the resultant contract will include all terms and conditions of the contract as it exists immediately prior to the exercise of the option(s), except for the following changes:

1. Part (a) of clause I.6 entitled “Ordering” shall be changed to show that orders may be issued from Contract Start Date to September 7, 2013.

(End of clause)

#### **F.8 PRODUCTION AND SUSTAINING ENGINEERING OPTION**

The Government may require the Contractor to accomplish the production and sustaining engineering activities described in Attachments J-20 and J-21. The Contracting Officer may exercise this option by issuance of a unilateral contract modification no later than 60 days prior to the beginning of the ordering period set forth in Schedule B, clause I.6 Ordering, and Schedule C, clause I.6 Ordering. Should the option be exercised, the resultant contract schedules will include all terms and conditions contained in Section J Attachments J-20 (Schedule B) and J-21 (Schedule C) immediately prior to the exercise of the option. The exercising of this option will assure the placement of the minimum order set forth in the “Ordering” clause in Section I of Attachments J-20 and J-21.

In the event the Government elects to exercise this option pursuant to the terms of this contract, the contract structure is as follows:

Schedule A	DDT&E
Schedule B	Production
Schedule C	Sustaining Engineering and Operations Support

(End of clause)

(END OF SECTION)

## **SECTION G – CONTRACT ADMINISTRATION DATA**

### **G.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

#### **I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

#### **II. NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
1852.227-70	MAY 2002	NEW TECHNOLOGY
1852.227-86	DEC 1987	COMMERCIAL COMPUTER SOFTWARE-- LICENSING
1852.242-71	DEC 1988	TRAVEL OUTSIDE OF THE UNITED STATES
1852.242-73	JUL 2000	NASA CONTRACTOR FINANCIAL MANAGEMENT REPORTING
1852.245-70	JUL 1997	CONTRACTOR REQUESTS FOR GOVERNMENT OWNED EQUIPMENT
1852.245-73	OCT 2003	FINANCIAL REPORTING OF NASA PROPERTY IN THE CUSTODY OF CONTRACTORS (In Paragraph b(3), the NASA office for receipt of NF1018 is: LF631/ Property Accounting and JB3/Property Administrator, 2101 NASA Parkway, Houston, TX 77058)

(End of By Reference Section)

### **G.2 SECURITY/BADGING REQUIREMENTS FOR FOREIGN NATIONAL VISITORS AND EMPLOYEES/REPRESENTATIVES OF FOREIGN CONTRACTORS. (JSC 52.204-91) (JAN 2006)**

- (a) An employee of a domestic Johnson Space Center (JSC) contractor or its subcontractor who is not a U.S. citizen (foreign national) may not be admitted to the JSC site for purposes of performing work without special arrangements. In addition, all employees or representatives of a foreign JSC contractor/subcontractor may not be admitted to the JSC site without special arrangements. For employees as described above, advance notice must be given to the Security Office of the host

installation [JSC or White Sands Test Facility (WSTF)] at least 3 weeks prior to the scheduled need for access to the site so that instructions on obtaining access may be provided. Contractors should be aware that approval for access to the site and issuance of a badge may take much longer than three weeks and sufficient lead time must be allowed to accommodate the approval process.

- (b) All visit/badge requests for persons described in (a) above must be entered in the NASA Foreign National Management System (NFMMS) for acceptance, review, concurrence and approval purposes. When an authorized company official requests a JSC or WSTF badge for site access, he/she is certifying that steps have been taken to ensure that its contractor or subcontractor employees, visitors, or representatives will not be given access to export-controlled or classified information for which they are not authorized. The authorized company officials shall serve as the contractor's representative(s) in certifying that all visit/badge request forms are processed in accordance with JSC and WSTF security and export control procedures. No foreign national, representative, or resident alien contractor/subcontractor employee shall be granted access into JSC or WSTF until approved and processed through the NFMMS. Unescorted access will not be granted unless a favorable National Agency Check (NAC) has been completed by the JSC Security Office, and an approved NASA Foreign National Visitor Security/Technology Control Plan (STTCP), (previously called the Access Control Plan) has been submitted and approved.
- (c) The contractor agrees that it will not employ for the performance of work onsite at the JSC or WSTF any individuals who are not legally authorized to work in the United States. If the JSC or WSTF Industrial Security Specialist or the contracting officer has reason to believe that any employee of the contractor may not be legally authorized to work in the United States and/or on the contract, the contractor may be required to furnish copies of Form I-9 (Employment Eligibility Verification), U.S. Department of Labor Application for Alien Employment Certification, and any other type of employment authorization document.

The contractor agrees to provide the information requested by the JSC or WSTF Security Office in order to comply with NASA policy directives and guidelines related to foreign visits to NASA facilities so that (1) the visitor/employee/ representative may be allowed access to JSC or other NASA Centers for performance of this contract, (2) required investigations can be conducted, and (3) required annual or revalidation reports can be submitted to NASA Headquarters. All requested information must be submitted in a timely manner in accordance with instructions provided by JSC or any other Center to be visited.

(End of clause)

### **G.3 AWARD FEE FOR END ITEM CONTRACTS**

- (a) The Contractor can earn award fee, or base fee, if any, from a minimum of zero dollars to the maximum stated in NASA FAR Supplement clause 1852.216-85, "Estimated Cost and Award Fee" in this contract. All award fee evaluations, with the exception of the last evaluation, will be interim evaluations. At the last evaluation, which is final, the Contractor's performance for the entire contract will be evaluated to determine total earned award fee. No award fee or base fee will be paid to the Contractor if the final award fee evaluation is "poor/unsatisfactory."



- (b) The Government will evaluate the Contractor's interim performance to monitor performance prior to contract completion and to provide feedback to the Contractor. The evaluation will be performed in accordance with Attachment J-7 to this contract. The Contractor may submit a self-evaluation of performance for each period under consideration. These self-evaluations will be considered by the Government in its evaluation. The Government will advise the Contractor in writing of the evaluation results. The plan may be revised unilaterally by the Government prior to the beginning of any rating period to redirect emphasis.
- (c) (1) Base fee, if applicable, will be paid in quarterly installments based on the percent of completion of the work as determined by the Contracting Officer.
- (2) Interim award fee payments will be made to the Contractor based on each interim evaluation. The amount of the interim award fee payment is limited to the lesser of the interim evaluation score or 80 percent of the fee allocated to that period less any provisional payments made during the period. All interim award fee payments will be superseded by the final award fee determination.
- (3) Provisional award fee payments will not be made under this contract pending each interim evaluation.
- (4) All interim (and provisional, if applicable) fee payments will be superseded by the fee determination made in the final award fee evaluation. The Government will then pay the Contractor, or the Contractor will refund to the Government the difference between the final award fee determination and the cumulative interim (and provisional, if applicable) fee payments. If the final award fee evaluation is "poor/unsatisfactory", any base fee paid will be refunded to the Government.
- (5) Payment of base fee, if applicable, will be made based on submission of an invoice by the Contractor. Payment of award fee will be made by NASA Accounts Payable based on an issuance of a unilateral modification by the Contracting Officer.
- (d) Award fee determinations are unilateral decisions made solely at the discretion of the Government.

(End of clause)

**G.4 SUBMISSION OF VOUCHERS FOR PAYMENT (NASA 1852.216-87) (MAR 1998)**

- (a) The designated billing office for cost vouchers for purposes of the Prompt Payment clause of this contract is indicated below. Public vouchers for payment of costs shall include a reference to the number of this contract.
- (b) (1) If the Contractor is authorized to submit interim cost vouchers directly to the NASA paying office, the original voucher should be submitted to:

NASA Lyndon B. Johnson Space Center  
Attn: Mail Code LF231

2101 NASA Parkway  
Houston, TX 77058

- (2) For any period that the Defense Contract Audit Agency has authorized the Contractor to submit interim cost vouchers directly to the Government paying office, interim vouchers are not required to be sent to the Auditor, and are considered to be provisionally approved for payment, subject to final audit.
- (3) Two copies of vouchers should be submitted as directed by the Contracting Officer.
- (c) If the Contractor is not authorized to submit interim cost vouchers directly to the paying office as described in paragraph (b), the Contractor shall prepare and submit vouchers as follows:
  - (1) One original Standard Form (SF) 1034, SF 1035, or equivalent Contractor's attachment to:

Cognizant DCAA/DCMA Office
  - (2) Five copies of SF 1034, SF 1035A, or equivalent Contractor's attachment to the following offices by insertion in the memorandum block of their names and addresses:
    - (i) Copy 1 NASA Contracting Officer
    - (ii) Copy 2 Auditor
    - (iii) Copy 3 Contractor
    - (iv) Copy 4 Contract administration office; and
    - (v) Copy 5 Project management office.
  - (3) The Contracting Officer may designate other recipients as required.
- (d) Public vouchers for payment of fee shall be prepared similarly to the procedures in paragraphs (b) or (c) of this clause, whichever is applicable, and be forwarded to:

NASA Lyndon B. Johnson Space Center  
BT/Exploration Procurement Office  
Attn: Contract Specialist  
2101 NASA Parkway  
Houston, TX 77058

This is the designated billing office for fee vouchers for purposes of the Prompt Payment clause of this contract.

- (e) In the event that amounts are withheld from payment in accordance with provisions of this contract, a separate voucher for the amount withheld will be required before payment for that amount may be made.

(End of clause)

**G.5 RESERVED**

(End of clause)

**G.6 DESIGNATION OF NEW TECHNOLOGY REPRESENTATIVE AND PATENT REPRESENTATIVE (NASA 1852.227-72) (JUL 1997)**

- (a) For purposes of administration of the clause of this contract entitled "New Technology" or "Patent Rights -- Retention by the Contractor (Short Form)", whichever is included, the following named representatives are hereby designated by the Contracting Officer to administer such clause:

AT/Technology Transfer & Commercialization Office  
AL/Patent Representative  
NASA Lyndon B. Johnson Space Center  
2101 NASA Parkway  
Houston, TX 77058

- (b) Reports of reportable items, and disclosure of subject inventions, interim reports, final reports, utilization reports, and other reports required by the clause, as well as any correspondence with respect to such matters, should be directed to the New Technology Representative unless transmitted in response to correspondence or request from the Patent Representative. Inquiries or requests regarding disposition of rights, election of rights, or related matters should be directed to the Patent Representative. This clause shall be included in any subcontract hereunder requiring a "New Technology" clause or "Patent Rights--Retention by the Contractor (Short Form)" clause, unless otherwise authorized or directed by the Contracting Officer. The respective responsibilities and authorities of the above-named representatives are set forth in 1827.305-370 of the NASA FAR Supplement.

(End of clause)

**G.7 TECHNICAL DIRECTION (NASA 1852.242-70) (SEPT 1993)**

- (a) Performance of the work under this contract is subject to the written technical direction of the Contracting Officer Technical Representative (COTR), who shall be specifically appointed by the Contracting Officer in writing in accordance with NASA FAR Supplement 1842.270. "Technical direction" means a directive to the Contractor that approves approaches, solutions, designs, or refinements; fills in details or otherwise completes the general description of work or documentation items; shifts emphasis among work areas or tasks; or furnishes similar instruction to the Contractor. Technical direction includes requiring studies and pursuit of certain lines of inquiry regarding matters within the general tasks and requirements in Section C of this contract.
- (b) The COTR does not have the authority to, and shall not, issue any instruction purporting to be technical direction that--
- (1) Constitutes an assignment of additional work outside the statement of work;

- (2) Constitutes a change as defined in the changes clause;
  - (3) Constitutes a basis for any increase or decrease in the total estimated contract cost, the fixed fee (if any), or the time required for contract performance.
  - (4) Changes any of the expressed terms, conditions, or specifications of the contract; or
  - (5) Interferes with the Contractor's rights to perform the terms and conditions of the contract.
- (c) All technical direction shall be issued in writing by the COTR.
- (d) The Contractor shall proceed promptly with the performance of technical direction duly issued by the COTR in the manner prescribed by this clause and within the COTR's authority. If, in the Contractor's opinion, any instruction or direction by the COTR falls within any of the categories defined in paragraph (b) of this clause, the Contractor shall not proceed but shall notify the Contracting Officer in writing within 5 working days after receiving it and shall request the Contracting Officer to take action as described in this clause. Upon receiving this notification, the Contracting Officer shall either issue an appropriate contract modification within a reasonable time or advise the Contractor in writing within 30 days that the instruction or direction is--
- (1) Rescinded in its entirety; or
  - (2) Within the requirements of the contract and does not constitute a change under the changes clause of the contract, and that the Contractor should proceed promptly with its performance.
- (e) A failure of the Contractor and contracting officer to agree that the instruction or direction is both within the requirements of the contract and does not constitute a change under the changes clause, or a failure to agree upon the contract action to be taken with respect to the instruction or direction, shall be subject to the Disputes clause of this contract.
- (f) Any action(s) taken by the Contractor in response to any direction given by any person other than the Contracting Officer or the COTR shall be at the Contractor's risk.

(End of clause)

#### **G.8 IDENTIFICATION OF EMPLOYEES. (JSC 52.242-92) (JAN 2006)**

At all times while on Government property, the contractor, subcontractors, their employees and agents shall wear badges which will be issued by the NASA Badging & Visitor Control Office, located in Building 110 at the Johnson Space Center (JSC), or at the Main Gate at the White Sands Test Facility (WSTF). JSC employee and visitor badges will be issued only between the hours of 6:00 a.m. to 7:30 p.m., Monday through Friday, and 7:00 am to 4:00 pm on Saturday and Sunday. WSTF employee badges will be issued only between the hours of 8 a.m. to 2 p.m., Monday through Friday. WSTF visitor badges will be issued on a 7-day a week, 24-hour a day basis. Resident aliens and foreign nationals/representatives shall be issued green foreign national badges.

Each individual who wears a badge shall be required to sign personally for the badge. The contractor shall be held accountable for issued badges and all other related items and must assure that they are returned to the NASA Badging & Visitor Control Offices upon completion of work under the contract in accordance with Security Management Directive (SMD) 500-15, "Security Termination Procedures." Failure to comply with the NASA contractor termination procedures upon completion of the work (e.g., return of badges, keys, CAA cards, clearance terminations, JSC Public Key Infrastructure (PKI)/special program deletions, etc.) may result in final payment being delayed.

(End of clause)

**G.9 INSTALLATION-ACCOUNTABLE GOVERNMENT PROPERTY (NFS 1852.245-71)**  
**(Alt I) (NOV 2004)**

- (a) The Government property described in the clause at 1852.245-77, G.11 List of Installation-Accountable Property and Services, shall be made available to the Contractor on a no-charge basis for use in performance of this contract. This property shall be utilized only within the physical confines of the NASA installation that provided the property. Under this clause, the Government retains accountability for, and title to, the property, and the Contractor assumes the following user responsibilities:

The Contractor shall establish and adhere to a system of written procedures for compliance with these user responsibilities. Such procedures must include holding employees liable, when appropriate, for loss, damage, or destruction of Government property.

- (b) (1) The official accountable recordkeeping, physical inventory, financial control, and reporting of the property subject to this clause shall be retained by the Government and accomplished by the installation Supply and Equipment Management Officer (SEMO) and Financial Management Officer. If this contract provides for the Contractor to acquire property, title to which will vest in the Government, the following additional procedures apply:

- (i) The Contractor shall not utilize the installation's central receiving facility for receipt of Contractor-acquired property. However, the Contractor shall provide listings suitable for establishing accountable records of all such property received, on a quarterly basis, to the Contracting Officer and the Supply and Equipment Management Officer.
  - (ii) The Contractor shall furnish a copy of each purchase order, prior to delivery by the vendor, to the installation central receiving area:
  - (iii) The Contractor shall establish a record of the property as required by FAR 45.5 and 1845.5 and furnish to the Industrial Property Officer a DD Form 1149 Requisition and Invoice/Shipping Document (or installation equivalent) to transfer accountability to the Government within 5 working days after receipt of the property by the Contractor. The Contractor is accountable for all Contractor-acquired property until the property is transferred to the Government's accountability.
  - (iv) Contractor use of Government property at an off-site location and off-site subcontractor use require advance approval of the contracting officer and notification of the SEMO. The Contractor shall assume accountability and financial reporting responsibility for such property. The Contractor shall establish records and property control procedures and maintain the property in accordance with the requirements of FAR Part 45.5 until its return to the installation.
- (2) After transfer of accountability to the Government, the Contractor shall continue to maintain such internal records as are necessary to execute the user responsibilities identified in paragraph

(a) and document the acquisition, billing, and disposition of the property. These records and supporting documentation shall be made available, upon request, to the SEMO and any other authorized representatives of the contracting officer.

(End of clause)

**G.10 LIST OF GOVERNMENT-FURNISHED PROPERTY (NASA 1852.245-76) (OCT 1988)**

For performance of work under this contract, the Government will make available Government property identified in Attachment J-11 of this contract on a no-charge-for-use basis. The Contractor shall use this property in the performance of this contract. Under the FAR 52.245 Government property clause of this contract, the Contractor is accountable for the identified property.

(End of clause)

**G.11 LIST OF INSTALLATION-ACCOUNTABLE PROPERTY AND SERVICES (NFS 1852.245-77) (JUL 1997)**

In accordance with the clause at 1852.245-71, G.9 Installation-Accountable Government Property, the Contractor is authorized use of the types of property and services listed below, to the extent they are available, in the performance of this contract within the physical borders of the installation which may include buildings and space owned or directly leased by NASA in close proximity to the installation, if so designated by the Contracting Officer.

- (a) Office space, work area space, and utilities. Government telephones are available for official purposes only; pay telephones are available for Contractor employees for unofficial calls.
- (b) General- and special-purpose equipment, including office furniture.
  - (1) Equipment to be made available is listed in Attachment J-10. The Government retains accountability for this property under the clause at 1852.245-71, G.9 Installation-Accountable Government Property, regardless of its authorized location.
  - (2) If the Contractor acquires property, title to which vests in the Government pursuant to other provisions of this contract, this property also shall become accountable to the Government upon its entry into Government records as required by the clause at 1852.245-71, G.9 Installation-Accountable Government Property.
  - (3) The Contractor shall not bring to the installation for use under this contract any property owned or leased by the Contractor, or other property that the Contractor is accountable for under any other Government contract, without the Contracting Officer's prior written approval.
- (c) Supplies from stores stock.
- (d) Publications and blank forms stocked by the installation.

- (e) Safety and fire protection for Contractor personnel and facilities.
- (f) Installation service facilities: See Attachment J-10
- (g) Medical treatment of a first-aid nature for Contractor personnel injuries or illnesses sustained during on-site duty.
- (h) Cafeteria privileges for Contractor employees during normal operating hours.
- (i) Building maintenance for facilities occupied by Contractor personnel.
- (j) Moving and hauling for office moves, movement of large equipment, and delivery of supplies.  
Moving services shall be provided on-site, as approved by the Contracting Officer.
- (k) The user responsibilities of the Contractor are defined in paragraph (a) of the clause at 1852.245-71, Installation-Accountable Government Property.

(End of clause)

(END OF SECTION)

## **SECTION H - SPECIAL CONTRACT REQUIREMENTS**

### **H.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

#### **I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

#### **II. NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
1852.208-81	NOV 2004	RESTRICTIONS ON PRINTING AND DUPLICATING
1852.223-70	APR 2002	SAFETY AND HEALTH
1852.223-75	FEB 2002	MAJOR BREACH OF SAFETY OR SECURITY
1852.223-76	JUL 2003	FEDERAL AUTOMOTIVE STATISTICAL TOOL REPORTING
1852.225-70	FEB 2000	EXPORT LICENSES (Insert "NASA facilities" in paragraph (b))
1852.228-76	DEC 1994	CROSS WAIVER OF LIABILITY FOR SPACE STATION ACTIVITIES
1852.242-72	AUG 1992	OBSERVANCE OF LEGAL HOLIDAYS (ALT II) (NOV 2000) (ALT I)(SEP 1989)
1852.244-70	APR 1985	GEOGRAPHIC PARTICIPATION IN THE AEROSPACE PROGRAM
1852.246-70	MAR 1997	MISSION CRITICAL SPACE SYSTEM PERSONNEL RELIABILITY PROGRAM

(End of By Reference Section)

#### **H.2 REPRESENTATION, CERTIFICATION, AND OTHER STATEMENTS (JSC 52.209-90) (SEP 1988)**

This contract incorporates Section K, Representations, Certifications, and Other Statements of Offerors, as set forth in the Contractor's proposal number P06-460570 dated 21 July 2006 by reference, with the same force and effect as if it were given in full text.

(End of clause)



### **H.3 SPECIAL PROVISION FOR CONTRACT CHANGES**

The parties agree that, notwithstanding the provisions of the “Changes” clause and the “Government Property” clause, no change made pursuant to the “Changes” clause shall give rise to an equitable adjustment in the estimated cost or fee or any other contract provision when said change causes an increase or decrease of **\$1,000,000** or less in the estimated cost of this contract. Each change shall be controlling in making this determination, and such change shall not, for purposes of determining the applicability of this clause, be added to any other change(s). The parties recognize that several changes may be grouped together in a bilateral modification for definitization; however, the dollar value of each individual change will be controlling in determining whether or not an equitable adjustment is in order.

(End of clause)

### **H.4 SUBCONTRACTING WITH RUSSIAN ENTITIES FOR GOODS OR SERVICES**

(a) Definitions: In this provision:

i) The term “Russian entities” includes the following:

- (1) The Russian Federal Space Agency (Roscosmos),
- (2) Any organization or entity under the jurisdiction or control of Roscosmos, or
- (3) Any other organization, entity, or element of the Government of the Russian Federation.

ii) The term “Organization or entity under the jurisdiction or control of Roscosmos” means an organization or entity that:

- (1) Was made part of the Russian Federal Space Agency upon its establishment on February 25, 1992;
- (2) Was transferred to the Russian Federal Space Agency by decree of the Russian Government on July 25, 1994, or May 12, 1998;
- (3) Was or is transferred to the Russian Aviation and Space Agency or Russian Federal Space Agency by decree of the Russian Government at any other time before, on, or after March 14, 2000; or
- (4) Is a joint stock company in which the Russian Aviation and Space Agency or Russian Federal Space Agency has at any time held controlling interest.

iii) The term “extraordinary payments” means payments in cash or in kind made or to be made by the United States Government prior to January 1, 2012, for work to be performed or services to be rendered prior to that date necessary to meet United States obligations under the Agreement Concerning Cooperation on the Civil International Space Station, with annex, signed at Washington January 29, 1998, and entered into force March 27, 2001, or any protocol, agreement, memorandum of understanding, or contract related thereto.

(b) This clause implements the Iran and Syria Nonproliferation Act (the Iran Nonproliferation Act as amended by the Iran Nonproliferation Amendments Act of 2005) to allow extraordinary payments prior to January 1, 2012 to Russian entities in connection with the International Space Station.

NASA has applied the restrictions in the Act to include funding of Russian entities via U.S. contractors.

(c) (i) The Contractor shall not subcontract with Russian entities without first receiving written approval from the Contracting Officer. In order to obtain this written approval to subcontract with any Russian entity as defined in paragraphs (a), the Contractor shall provide the Contracting Officer with the following information related to each planned new subcontract and any change to an existing subcontract with entities that fit the description in paragraphs (a):

- (1) A detailed description of the subcontracting entity, including its name, address, and a point of contact, as well as a detailed description of the proposed subcontract including the specific purpose of payments that will be made under the subcontract.
- (2) The contractor shall provide certification that the subcontracting entity is not on any of the denied parties, specially designated nationals and entities of concern lists found at:  
<http://www.hq.nasa.gov/office/oer/nasaecp/Welcome.html>

**Denied Parties, Specially Designated Nationals and Entities of Concern**

BIS's Listing of Entities of Concern UPDATED

BIS's List of Denied Parties UPDATED

Debarred Parties Listing

OFAC's List of Specially Designated Nationals *(Adobe PDF format)*

List of Unverified Persons in Foreign Countries UPDATED

(ii) Unless relief is granted by the Contracting Officer, the information necessary to obtain approval to subcontract shall be provided to the Contracting Officer 30 business days prior to executing any planned subcontract with entities defined in paragraph (a).

(d) After receiving approval to subcontract, the contractor shall provide the Contracting Officer with a report every six-months which documents the individual extraordinary payments made to an entity in paragraph a. The reports are due on July 15<sup>th</sup> and January 15<sup>th</sup>. The July 15<sup>th</sup> report should document all of the individual extraordinary payments made from the previous January through June. The January 15<sup>th</sup> report should document all of the individual extraordinary payments made from the previous July through December. The content of the report shall provide the following information for each time an extraordinary payment is made to an entity in paragraph a:

- (i) The name of the entity
- (ii) The subcontract number
- (iii) The amount of the payment
- (iv) The date of the payment

(e) The Contracting Officer may direct the Contractor to provide additional information for any other prospective or existing subcontract at any tier. The Contracting Officer may direct the Contractor to terminate for the convenience of the government any subcontract at any tier with an entity described in paragraphs (a), subject to an equitable adjustment.

- (f) Notwithstanding FAR 52.216-7, "Allowable Cost and Payments," on or after January 1, 2012 the contractor shall be responsible to make payments to entities defined in paragraphs (a) of this provision. Any subcontract with entities defined in paragraph (a), therefore, should be completed in sufficient time to permit the U.S. Government to make extraordinary payments on subcontracts with Russian entities on or before December 31, 2011.
- (g) The Contractor shall include the substance of this clause in all its subcontracts, and shall require such inclusion in all other subcontracts of any tier. The Contractor shall be responsible to obtain written approval from the Contracting Officer to enter into any tier subcontract that involves entities defined in paragraph (a).

(End of clause)

#### **H.5 COMPLIANCE WITH APPLICABLE CENTER POLICIES AND PROCEDURES**

Contractor and subcontractor personnel (regardless of tier) working on-site at NASA Centers shall comply with all applicable center policies and procedures. The Contractor shall keep itself and pertinent subcontractors up-to-date with the latest revisions of these policies and procedures. The Contractor shall promptly take corrective action upon receipt of notice from the Contracting Officer of noncompliance with any applicable center policy or procedure.

(End of clause)

#### **H.6 MODIFIED DATA RIGHTS**

The following data items are authorized to use the following modified Limited Rights Notice and Restricted Rights Notice (FAR 52.227-14)



**Restricted Rights Notice (June 1987) (Modified)**

(a) This computer software is submitted with restricted rights under Government Contract No. \_\_\_\_\_ (and subcontract \_\_\_\_\_, if appropriate). It may not be used, reproduced, or disclosed by the Government except as provided in paragraph (b) of this Notice or as otherwise expressly stated in the contract.

(b) This computer software may be-

(1) Used or copied for use in or with the computer or computers for which it was acquired, including use at any Government installation to which such computer or computers may be transferred;

- (2) Used or copied for use in a backup computer if any computer for which it was acquired is inoperative;
- (3) Reserved.
- (4) Modified, adapted, or combined with other computer software, *provided* that the modified, combined, or adapted portions of the derivative software incorporating restricted computer software are made subject to the same restricted rights;
- (5) Disclosed to and reproduced for use by Government personnel and Government support service Contractors on a need to know basis in accordance with paragraphs (b)(1) through (4) of this clause, provided the Government makes such disclosure or reproduction subject to these restricted rights and the Contracting Officer identifies the Government Support Contractors, thus allowing the Contractor and Support Contractor to execute separate non-disclosure agreements (NDA) or No-Cost License Agreements, if applicable. If applicable, these separate agreements will be between the Contracting Companies and not incorporated into this Government Contract; and
- (6) Used or copied for use in or transferred to a replacement computer.
- (c) Notwithstanding the foregoing, if this computer software is published copyrighted computer software, it is licensed to the Government, without disclosure prohibitions, with the minimum rights set forth in paragraph (b) of this clause.
- (d) Any other rights or limitations regarding the use, duplication, or disclosure of this computer software are to be expressly stated in, or incorporated in, the contract.
- (e) This Notice shall be marked on any reproduction of this computer software, in whole or in part.

(End of notice)

## **H.7 INDEMNIFICATION FOR UNUSUALLY HAZARDOUS RISKS**

a) The Government recognizes that the Contractor's approach to fulfill the requirements of this contract might involve conditions considered to constitute unusually hazardous risks resulting in potential third party liability exceeding insurance coverage the Contractor could reasonably be expected to purchase and maintain, considering the availability, cost, and terms and conditions of such insurance. In the event the Contractor believes such conditions exist and necessitate indemnification by the Government, the Contractor shall provide documentation and rationale adequate to substantiate processing of such requests in accordance with applicable laws and regulations. The Contractor shall furnish the information required in accordance with FAR 50.403-1 and NASA FAR Supplement 1850.403. Reference to these FAR and NASA FAR Supplement sections is not an indication that NASA has determined indemnification to be applicable. The Contractor's request for indemnification must explain under what authority NASA can provide indemnification for unusually hazardous risks associated with performance of the contract. In addition to identifying a sufficient legal basis for indemnification, the Contractor's request for indemnification also must substantiate a sufficient factual basis for indemnification by explaining specifically what work under the contract poses unusually hazardous risks.

b) The Government will consider a request for indemnification for unusually hazardous risks in accordance with the foregoing paragraph. In the event the Government denies the Contractor's request for indemnification, the parties will enter into good faith negotiations to determine the appropriate course of action concerning potential third party liability.

(End of clause)

**H.8 *RESERVED***

(End of clause)

**H.9 RESERVED**

(End of clause)

**H.10 PATENT RIGHTS**

This contract includes the New Technology Clause 1852.227-70. It is anticipated that the Contractor may have Contractor background inventions that could be applied to Contract research and incorporated into deliverables under the Contract. The Government may need rights to use such Contractor background inventions in order to practice technologies produced under this Contract in other Government contracts. Thus, Contracting Officer permission is required before Contractor background inventions may be included in Contract deliverables. To the extent a Contractor background invention has been Federally funded, the Government will receive its government-purpose license rights to practice the background invention. Where there is no Federal funding of the background invention, the Contractor will identify to the Contracting Officer the rights that it proposes to grant the Government to use such invention in other Government contracts. The Government shall receive a government-purpose license to practice any Contractor background invention where such Contracting Officer permission is not obtained prior to incorporating its background inventions into Contractor work. This clause or a clause substantially the same shall be included in all subcontracts at any tier.

(End of clause)

**H.11 TASK ORDERING PROCEDURE (NFS 1852.216-80) (OCT 1996)**

- (a) Only the Contracting Officer may issue task orders to the Contractor, providing specific authorization or direction to perform work within the scope of the contract and as specified in the schedule. The Contractor may incur costs under this contract in performance of task orders and task order modifications issued in accordance with this clause. No other costs are authorized unless otherwise specified in the contract or expressly authorized by the Contracting Officer.
- (b) Prior to issuing a task order, the Contracting Officer shall provide the Contractor with the following data:
  - 1) A functional description of the work identifying the objectives or results desired from the contemplated task order.
  - 2) Proposed performance standards to be used as criteria for determining whether the work requirements have been met.

- 3) A request for a task plan from the Contractor to include the technical approach, period of performance, appropriate cost information, and any other information required to determine the reasonableness of the Contractor's proposal.
- (c) Within 30 calendar days after receipt of the Contracting Officer's request, the Contractor shall submit a task plan conforming to the request.
- (d) After review and any necessary discussions, the Contracting Officer may issue a task order to the Contractor containing, as a minimum, the following:
- (1) Date of the order.
  - (2) Contract number and order number.
  - (3) Functional description of the work identifying the objectives or results desired from the task order, including special instructions or other information necessary for performance of the task.
  - (4) Performance standards, and where appropriate, quality assurance standards.
  - (5) Maximum dollar amount authorized (cost and fee or price). This includes allocation of award fee among award fee periods, if applicable.
  - (6) Any other resources (travel, materials, equipment, facilities, etc.) authorized.
  - (7) Delivery/performance schedule including start and end dates.
  - (8) If contract funding is by individual task order, accounting and appropriation data.
- (e) The Contractor shall provide acknowledgment of receipt to the Contracting Officer within 5 calendar days after receipt of the task order.
- (f) If time constraints do not permit issuance of a fully defined task order in accordance with the procedures described in paragraphs (a) through (d), a task order which includes a ceiling price may be issued.
- (g) The Contracting Officer may amend tasks in the same manner in which they were issued.
- (h) In the event of a conflict between the requirements of the task order and the Contractor's approved task plan, the task order shall prevail.

(End of clause)

## **H.12 ELECTRONIC DATA ACCESS**

The Contractor shall implement and maintain an Electronic Data Access (EDA) with the Government utilizing web-enabled technology at the Unclassified, For Official Use Only (FOUO), and Contractor Proprietary levels during the CEV Phase 2 contract. The EDA shall establish and maintain the capability for access to the contracting management information system, working data, including subcontractor data, developed to support the management and engineering efforts of the project. The Government will provide a list of authorized personnel for full electronic access to the Contractor's database after contract award. The Contractor's database shall be compatible with typical Government PC-based systems using the MS Office 2000 suite of applications (e.g. Word, Excel, PowerPoint, and Project) as well as Adobe Acrobat 7.0. The Contractor shall establish the



aforementioned EDA system capable of fully supporting government access information within thirty (30) calendar days of contract start.

(End of clause)

### **H.13 SPACE FLIGHT MOTIVATION AWARENESS PROGRAM**

The Contractor shall establish a program for Space Flight Awareness (SFA). The Program's goals and objectives are to:

- Ensure every employee involved in human space flight is aware of the importance of their role in promoting safety, quality and mission success.
- Participation in NASA-Industry Space Flight Awareness Program.
- Increase awareness of the Human Space Flight Program accomplishments, milestones and objectives with a focus on safety and mission success.
- Conduct events and products that motivate and recognize the workforce, and enhance employee morale.
- Function as an internal communications team to disseminate key educational, program/management safety, quality, and mission success messages and themes.

(End of clause)

### **H.14 SMALL BUSINESS SUBCONTRACTING GOALS**

In meeting the intent of Small /Disadvantaged business participation under this contract, the Contractor agrees to flow down to all first-tier large business subcontractors, as percentages (with corresponding dollar amounts) of their total contract value the same socioeconomic goals agreed to under the prime Contractor subcontracting plan. The Contractor agrees to flow down the goals to other tier large business subcontractors.

(End of clause)

### **H.15 SUBCONTRACTOR SMALL BUSINESS REPORTING**

Contractor shall require first-tier large business subcontractors to report lower-tier Small Business Concern subcontracting dollars on a semi-annual basis. This reporting is conducted through the Electronic Subcontracting Reporting Systems (eSRS) located at <http://www.esrs.gov>.

(End of clause)

### **H.16 KEY PERSONNEL AND FACILITIES (NASA 1852.235-71) (MAR 1989)**

- (a) The personnel and/or facilities listed below (or specified in the contract Schedule) are considered essential to the work being performed under this contract. Before removing, replacing, or diverting

any of the listed or specified personnel or facilities, the Contractor shall (1) notify the Contracting Officer reasonably in advance and (2) submit justification (including proposed substitutions) in sufficient detail to permit evaluation of the impact on this contract.

- (b) The Contractor shall make no diversion without the Contracting Officer's written consent; provided, that the Contracting Officer may ratify in writing the proposed change, and that ratification shall constitute the Contracting Officer's consent required by this clause.
- (c) The list of personnel and/or facilities (shown below or as specified in the contract Schedule) may, with the consent of the contracting parties, be amended from time to time during the course of the contract to add or delete personnel and/or facilities.

NAME

TITLE

(End of clause)

#### **H.17 ASSOCIATE CONTRACTOR AGREEMENTS**

- (a) In order to achieve the requirements of this contract, the Contractor shall establish, in conjunction with the NASA CEV Project Office, the means for coordination and exchange of information with associate contractors. The information to be exchanged shall be that required by the associate contractors in the execution of their respective contract requirements. The associate contractors contemplated by this clause have not been established at the time of contract award, but will be added by contract modification to this paragraph as required. The associate contractors will supply other elements of the Constellation Program, such as a launch vehicle, earth departure stage, or lunar surface access module.
- (b) The Contractor shall document agreements with other associate contractors described in (a) above via associate contractor agreements. The Government will not be a party in such associate contractor agreements. A copy of each such agreement shall be provided to the Contracting Officer. All costs associated with such agreements are included in the negotiated cost of this contract.
- (c) The Contractor is not relieved of any contract requirements or entitled to any adjustments to the contract terms because of the failure to resolve a disagreement with an associate contractor. Liability for the improper disclosure of any proprietary data contained in or referenced by any agreement shall rest with the parties to the agreement, and not the Government.

(End of clause)

## **H.18 DATA DELIVERABLE MARKING REQUIREMENTS FOR EXPORT CONTROL**

- (a) The Contractor shall perform an export control assessment for all data deliverable items shown in Attachment J-2, Data Procurement Document.
- (b) If a product is determined to contain information controlled by the International Traffic in Arms Regulations, the following statement shall be included on the product cover page.

### **International Traffic in Arms Regulations (ITAR) Notice**

This document contains information on paragraphs [*offeror to list specific pages subject to ITAR control*] falls under the purview of the U.S. Munitions List (USML), as defined in the International Traffic in Arms Regulations (ITAR), 22 CFR 120-130, and is export controlled. It shall not be transferred to foreign nationals in the U.S. or abroad, without specific approval of a knowledgeable NASA export control official, and/or unless an export license/license exemption is obtained/available from the United States Department of State. Violations of these regulations are punishable by fine, imprisonment, or both.

- (c) If a product is determined to contain information controlled by the Export Administration Regulations and which requires a license or exception prior to export, the following statement shall be included on the product cover page:

### **Export Administration Regulations (EAR) Notice**

This document contains information on [*offeror to list specific pages subject to the EAR*] within the purview of the Export Administration Regulations (EAR), 15 CFR 730-744, and is export controlled. It may not be transferred to foreign nationals in the U.S. or abroad, without specific approval of a knowledgeable NASA export control official, and/or unless an export license/license exception is obtained/available from the Bureau of Industry and Security (BIS), United States Department of Commerce. Violations of these regulations are punishable by fine, imprisonment, or both.

- d) If a product has been determined to be suitable for public release, it shall be so labeled.

(End of clause)

## **H.19 APPLICATION OF U.S. SPACE TRANSPORTATION POLICY**

All effort under this contract shall be consistent with the National Security Presidential Directive/NSPD-40 (U.S. Space Transportation Policy.)

(End of clause)

## **H.20 COMPLIANCE WITH APPLICABLE ELECTRONIC AND INFORMATION TECHNOLOGY (EIT) POLICIES**

The Contractor shall aid the NASA CEV Project office in the preparation of Information Technology reporting and documentations. The Contractor agrees to produce for the NASA CEV Project Office documents related to NPR 2810.1, Security of Information Technology. The Contractor further agrees to

aid NASA in documentation related to OMB circular A-11, Preparation, submission, and Execution of Budget; OMB A-130, Management of Federal Information; Exhibit 53, List of IT Costs and Budget Items; and Exhibit 300, capital Asset Plan Reports on Major IT Investments.

(End of clause)

## **H.21 LIMITATION OF FUTURE CONTRACTING (NFS 1852.209-71) (DEC 1988)**

- (a) The Contracting Officer has determined that this acquisition may give rise to a potential organizational conflict of interest. Accordingly, the attention of prospective offerors is invited to FAR Subpart 9.5--Organizational Conflicts of Interest.
- (b) The nature of this conflict is the Contractor may be in a position to favor its own products and capabilities and may have an unfair competitive advantage.
- (c) The restrictions upon future contracting are as follows:
  - (1) If the Contractor, under the terms of this contract, or through the performance of tasks pursuant to this contract, is required to develop specifications or statements of work that are to be incorporated into a solicitation, the Contractor shall be ineligible to perform the work described in that solicitation as a prime or first-tier subcontractor under an ensuing NASA contract. This restriction shall remain in effect for a reasonable time, as agreed to by the Contracting Officer and the Contractor, sufficient to avoid unfair competitive advantage or potential bias (this time shall in no case be less than the duration of the initial production contract). NASA shall not unilaterally require the Contractor to prepare such specifications or statements of work under this contract.
  - (2) To the extent that the work under this contract requires access to proprietary, business confidential, or financial data of other companies, and as long as these data remain proprietary or confidential, the Contractor shall protect these data from unauthorized use and disclosure and agrees not to use them to compete with those other companies.

(End of clause)

## **H.22 ADVANCE AGREEMENT FOR CONTRACTOR INVESTMENTS**

The parties agree that the contract might be partly based on corporate contributions/investment as specified in the proposal or as negotiated in the contract. Costs related to the Contractor's contributions or investments shall be reported under the contract as they are incurred, for purposes of tracking the Contractor's costs as well as the full costs of the project. The Contractor agrees that, should the Government's requirements change or should all or part of the work under the contract be terminated, all reported costs as well as unreported costs related to the Contractor's contributions and investment will be unallowable as part of any contract settlement.

(End of clause)

## **H.23 RESERVED**

(End of clause)



## **PART II - CONTRACT CLAUSES**

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### **SECTION I - CONTRACT CLAUSES**

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#### **I.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

#### **I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
52.202-1	JUL 2004	DEFINITIONS
52.203-3	APR 1984	GRATUITIES
52.203-5	APR 1984	COVENANT AGAINST CONTINGENT FEES
52.203-6	JUL 1995	RESTRICTIONS ON SUBCONTRACTOR SALES TO THE GOVERNMENT
52.203-7	JUL 1995	ANTI-KICKBACK PROCEDURES
52.203-8	JAN 1997	CANCELLATION, RESCISION, AND RECOVERY OF FUNDS FOR ILLEGAL OR IMPROPER ACTIVITY
52.203-10	JAN 1997	PRICE OR FEE ADJUSTMENT FOR ILLEGAL OR IMPROPER ACTIVITY
52.203-12	JUN 2003	LIMITATION ON PAYMENTS TO INFLUENCE CERTAIN FEDERAL TRANSACTIONS
52.204-2	AUG. 1996	SECURITY REQUIREMENTS
52.204-4	AUG 2000	PRINTING/COPYING DOUBLE SIDED ON RECYCLED PAPER
52.204-7	OCT 2003	CENTRAL CONTRACTOR REGISTRATION
52.204-9	JAN 2006	PERSONAL IDENTITY VERIFICATION OF CONTRACTOR PERSONNEL (Please see Attachment J-19 PIV Card Issuance Procedures)
52.209-6	JAN 2005	PROTECTING THE GOVERNMENT'S INTEREST WHEN SUBCONTRACTING WITH CONTRACTORS DEBARRED, SUSPENDED, OR PROPOSED FOR DEBARMENT
52.211-5	AUG 2000	MATERIAL REQUIREMENTS
52.211-15	SEPT 1990	DEFENSE PRIORITY AND ALLOCATION REQUESTS
52.215-2	JUNE 1999	AUDIT AND RECORDS--NEGOTIATION
52.215-8	OCT 1997	ORDER OF PRECEDENCE--UNIFORM CONTRACT

		FORMAT
52.215-10	OCT 1997	PRICE REDUCTION FOR DEFECTIVE COST OR PRICING DATA
52.215-12	OCT 1997	SUBCONTRACTOR COST OR PRICING DATA
52.215-14	OCT 1997	INTEGRITY OF UNIT PRICES
52.215-15	OCT 2004	PENSION ADJUSTMENTS AND ASSET REVERSIONS
52.215-18	JUL 2005	REVERSION OR ADJUSTMENT OF PLANS FOR POSTRETIREMENT BENEFITS (PRB) OTHER THAN PENSIONS
52.215-19	OCT 1997	NOTIFICATION OF OWNERSHIP CHANGES
52.215-21	OCT 1997	REQUIREMENTS FOR COST OR PRICING DATA OR INFORMATION OTHER THAN COST OR PRICING DATA—MODIFICATIONS (ALT II) (OCT 1997) (ALT III) (OCT 1997) Insert (d) Electronic media: <u>Microsoft Office ®</u>
52.216-7	DEC 2002	ALLOWABLE COST AND PAYMENT
52.219-8	MAY 2005	UTILIZATION OF SMALL BUSINESS CONCERNS
52.219-9	JUL 2005	SMALL BUSINESS SUBCONTRACTING PLAN (ALT II) (OCT 2001)
52.219-16	JAN 1999	LIQUIDATED DAMAGES—SUBCONTRACTING PLAN
52.219-25	OCT 1999	SMALL DISADVANTAGED BUSINESS PARTICIPATION PROGRAM- DISADVANTAGED STATUS AND REPORTING
52.222-1	FEB 1997	NOTICE TO THE GOVERNMENT OF LABOR DISPUTES
52.222-3	JUN 2003	CONVICT LABOR
52.222-4	JUL 2005	CONTRACT WORK HOURS AND SAFETY STANDARDS ACT-OVERTIME COMPENSATION
52.222-20	DEC 1996	WALSH-HEALEY PUBLIC CONTRACTS ACT
52.222-21	FEB 1999	PROHIBITION OF SEGREGATED FACILITIES
52.222-26	APR 2002	EQUAL OPPORTUNITY
52.222-35	DEC 2001	EQUAL OPPORTUNITY FOR SPECIAL DISABLED VETERANS, VETERANS OF THE VIETNAM ERA, AND OTHER ELIGIBLE VETERANS
52.222-36	JUN 1998	AFFIRMATIVE ACTION FOR WORKERS WITH DISABILITIES
52.222-37	DEC 2001	EMPLOYMENT REPORTS ON SPECIAL DISABLED VETERANS, VETERANS OF THE VIETNAM ERA, AND OTHER ELIGIBLE VETERANS
52.222-39	DEC 2004	NOTIFICATION OF EMPLOYEE RIGHTS CONCERNING

		PAYMENT OF UNION DUES OR FEES
52.223-3	JAN 1997	HAZARDOUS MATERIAL IDENTIFICATION AND MATERIAL SAFETY DATA (ALT I) (JUL 1995) ( <i>Insert NONE in paragraph b</i> )
52.223-5	AUG 2003	POLLUTION PREVENTION AND RIGHT-TO-KNOW INFORMATION, (ALT I)(AUG 2003), (ALT II)(AUG 2003)
52.223-6	MAY 2001	DRUG-FREE WORKFORCE
52.223-14	AUG 2003	TOXIC CHEMICAL RELEASE REPORTING
52.224-1	APR 1984	PRIVACY ACT
52.225-5	JAN 2005	TRADE AGREEMENTS
52.225-8	FEB 2000	DUTY-FREE ENTRY
52.225-13	MAR 2005	RESTRICTIONS ON CERTAIN FOREIGN PURCHASES
52.227-1	JUL 1995	AUTHORIZATION AND CONSENT (ALT I) (APR 1984)
52.227-2	AUG 1996	NOTICE AND ASSISTANCE REGARDING PATENT AND COPYRIGHT INFRINGEMENT
52.227-16	JUN 1987	ADDITIONAL DATA REQUIREMENTS
52.227-21	JAN 1997	TECHNICAL DATA DECLARATION, REVISION, AND WITHHOLDING OF PAYMENT-MAJOR SYSTEMS (Offeror to fill in (if appropriate) (b)(1).)
52.228-7	MAR 1996	INSURANCE--LIABILITY TO THIRD PERSONS
52.230-2	APR 1998	COST ACCOUNTING STANDARDS
52.230-6	NOV 1999	ADMINISTRATION OF COST ACCOUNTING STANDARDS
52.232-17	JUN 1996	INTEREST
52.232-18	APR 1984	AVAILABILITY OF FUNDS
52.232-22	APR 1984	LIMITATION OF FUNDS
52.232-23	JAN 1986	ASSIGNMENT OF CLAIMS
52.232-25	OCT 2003	PROMPT PAYMENT
52.232-34	MAY 1999	PAYMENT BY ELECTRONIC FUNDS TRANSFER--OTHER THAN CENTRAL CONTRACTOR REGISTRATION ( <i>Insert in paragraph (b)(1) "no later than concurrent with the first request for payment".</i> )
52.233-1	JULY 2002	DISPUTES (ALT I) (DEC 1991)
52.233-3	AUG 1996	PROTEST AFTER AWARD (ALT I) (JUN 1985)
52.233-4	OCT 2004	APPLICABLE LAW FOR BREACH OF CONTRACT CLAIM
52.237-2	APR 1984	PROTECTION OF GOVERNMENT BUILDINGS, EQUIPMENT, AND VEGETATION



52.242-1	APR 1984	NOTICE OF INTENT TO DISALLOW COSTS
52.242-3	MAY 2001	PENALTIES FOR UNALLOWABLE COSTS
52.242-4	JAN 1997	CERTIFICATION OF FINAL INDIRECT COSTS
52.242-13	JUL 1995	BANKRUPTCY
52.243-2	AUG 1987	CHANGES--COST-REIMBURSEMENT (ALT V) (APR 1984)
52.243-6	APR 1984	CHANGE ORDER ACCOUNTING
52.243-7	APR 1984	NOTIFICATION OF CHANGES
52.244-2	AUG 1998	SUBCONTRACTS (ALT I) (MAR 2005) (Insert "All foreign subcontracts, other subcontracts greater than \$50 Million, and any subcontracts with Limited Data Rights" in paragraph (e) and insert "none" in paragraph (k))
52.244-5	DEC 1996	COMPETITION IN SUBCONTRACTING
52.244-6	DEC 2004	SUBCONTRACTS FOR COMMERCIAL ITEMS
52.245-1	APR 1984	PROPERTY RECORDS
52.245-5	MAY 2004	GOVERNMENT PROPERTY (COST-REIMBURSEMENT, TIME-AND-MATERIAL, OR LABOR-HOUR CONTRACTS) (DEVIATION) (AS MODIFIED BY NASA PIC 04-12) ) (See attachment J-11)
52.245-17	MAY 2004	SPECIAL TOOLING
52.245-18	FEB 1993	SPECIAL TEST EQUIPMENT
52.246-24	FEB 1997	LIMITATION OF LIABILITY – HIGH VALUE ITEMS, (ALT I) (APR 1984)
52.247-1	APR 1984	COMMERCIAL BILL OF LADING NOTATIONS
52.247-63	JUN 2003	PREFERENCE FOR U.S.-FLAG AIR CARRIERS
52.248-1	FEB 2000	VALUE ENGINEERING
52.249-6	MAY 2004	TERMINATION (COST-REIMBURSEMENT)
52.249-14	APR 1984	EXCUSABLE DELAYS
52.251-1	APR 1984	GOVERNMENT SUPPLY SOURCES
52.251-2	JAN 1991	INTERAGENCY FLEET MANAGEMENT SYSTEMS VEHICLES AND RELATED SERVICES
52.253-1	JAN 1991	COMPUTER GENERATED FORMS

## **II. NASA FAR SUPPLEMENT (48 CFR CHAPTER 18) PROVISIONS**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
1852.203-70	JUN 2001	DISPLAY OF INSPECTOR GENERAL HOTLINE POSTERS
1852.216-89	JUL 1997	ASSIGNMENT AND RELEASE FORMS
1852.219-74	SEPT 1990	USE OF RURAL AREA SMALL BUSINESSES
1852.219-75	MAY 1999	SMALL BUSINESS SUBCONTRACTING REPORTING
1852.219-76	JUL 1997	NASA 8 PERCENT GOAL
1852.223-74	MAR 1996	DRUG-AND ALCOHOL-FREE WORKFORCE
1852.227-86	DEC 1987	COMMERCIAL COMPUTER SOFTWARE-- LICENSING
1852.227-87	APR 1989	TRANSFER OF TECHNICAL DATA UNDER SPACE STATION INTERNATIONAL AGREEMENTS
1852.228-75	OCT 1988	MINIMUM INSURANCE COVERAGE
1852.235-70	FEB 2003	CENTER FOR AEROSPACE INFORMATION
1852.237-70	DEC 1988	EMERGENCY EVACUATION PROCEDURES
1852.237-72	JUN 2005	ACCESS TO SENSITIVE INFORMATION
1852.237-73	JUN 2005	RELEASE OF SENSITIVE INFORMATION
1852.242-78	APR 2001	EMERGENCY MEDICAL SERVICES AND EVACUATION
1852.243-71	MAR 1997	SHARED SAVINGS

(End of By Reference Section)

### **I. 2 APPROVAL OF CONTRACT (FAR 52.204-1) (DEC 1989)**

This contract is subject to the written approval of the JSC Procurement Officer and shall not be binding until so approved.

(End of clause)

### **I.3 SECURITY CLASSIFICATION REQUIREMENTS (1852.204-75) (SEPT 1989)**

Performance under this contract will involve access to and/or generation of classified information, work in a security area, or both, up to the level of “secret”. See Federal Acquisition Regulation clause 52.204-2 in this contract and DD Form 254, Contract Security Classification Specification, Attachment J-20.

(End of clause)

**I. 4 SECURITY REQUIREMENTS FOR UNCLASSIFIED INFORMATION TECHNOLOGY RESOURCES (NASA 1852.204-76) (NOV 2004)**

a) The Contractor shall be responsible for Information Technology security for all systems connected to a NASA network or operated by the Contractor for NASA, regardless of location. This clause is applicable to all or any part of the contract that includes information technology resources or services in which the Contractor must have physical or electronic access to NASA’s sensitive information contained in unclassified systems that directly support the mission of the Agency. This includes information technology, hardware, software, and the management, operation, maintenance, programming, and system administration of computer systems, networks, and telecommunications systems. Examples of tasks that require security provisions include:

- (1) Computer control of spacecraft, satellites, or aircraft or their payloads;
- (2) Acquisition, transmission or analysis of data owned by NASA with significant replacement cost should the Contractor’s copy be corrupted; and
- (3) Access to NASA networks or computers at a level beyond that granted the general public, e.g. bypassing a firewall.

b) The Contractor shall provide, implement, and maintain an IT Security Plan. This plan shall describe the processes and procedures that will be followed to ensure appropriate security of IT resources that are developed, processed, or used under this contract. The plan shall describe those parts of the contract to which this clause applies. The Contractor’s IT Security Plan shall be compliant with Federal laws that include, but are not limited to, the Computer Security Act of 1987 (40 U.S.C. 1441 et seq.) and the Government Information Security Reform Act of 2000. The plan shall meet IT security requirements in accordance with Federal and NASA policies and procedures that include, but are not limited to:

- (1) OMB Circular A-130, Management of Federal Information Resources, Appendix III, Security of Federal Automated Information Resources;
- (2) NASA Procedures and Guidelines (NPR) 2810.1, Security of Information Technology; and
- (3) Chapter 3 of NPR 1620.1, NASA Security Procedural Requirements.

c) Within 45 calendar days after contract award, the Contractor shall submit for NASA approval an IT Security Plan. This plan must be consistent with and further detail the approach contained in the offeror’s proposal or sealed bid that resulted in the award of this contract and in compliance with the requirements stated in this clause. The plan, as approved by the Contracting Officer, shall be incorporated into the contract as a compliance document.

- d)(1) Contractor personnel requiring privileged access or limited privileged access to systems operated by the Contractor for NASA or interconnected to a NASA network shall be screened at an appropriate level in accordance with NPR 2810.1, Section 4.5; NPR 1620.1, Chapter 3; and paragraph (d)(2) of this clause. Those Contractor personnel with non-privileged access do not require personnel screening. NASA shall provide screening using standard personnel screening National Agency Check (NAC) forms listed in paragraph (d)(3) of this clause, unless Contractor screening in accordance with paragraph (d)(4) is approved. The Contractor shall submit the required forms to the NASA Center Chief of Security (CCS) within fourteen (14) days after contract award or assignment of an individual to a position requiring screening. The forms may be obtained from the CCS. At the option of the government, interim access may be granted pending completion of the NAC.
- (2) Guidance for selecting the appropriate level of screening is based on the risk of adverse impact to NASA missions. NASA defines three levels of risk for which screening is required (IT-1 has the highest level of risk):
- (i) **IT-1** -- Individuals having privileged access or limited privileged access to systems whose misuse can cause very serious adverse impact to NASA missions. These systems include, for example, those that can transmit commands directly modifying the behavior of spacecraft, satellites or aircraft.
  - (ii) **IT-2** -- Individuals having privileged access or limited privileged access to systems whose misuse can cause serious adverse impact to NASA missions. These systems include, for example, those that can transmit commands directly modifying the behavior of payloads on spacecraft, satellites or aircraft; and those that contain the primary copy of "level 1" data whose cost to replace exceeds one million dollars.
  - (iii) **IT-3** -- Individuals having privileged access or limited privileged access to systems whose misuse can cause significant adverse impact to NASA missions. These systems include, for example, those that interconnect with a NASA network in a way that exceeds access by the general public, such as bypassing firewalls; and systems operated by the Contractor for NASA whose function or data has substantial cost to replace, even if these systems are not interconnected with a NASA network.
- (3) Screening for individuals shall employ forms appropriate for the level of risk as follows:
- (i) IT-1: Fingerprint Card (FC) 258 and Standard Form (SF) 85P, Questionnaire for Public Trust Positions;
  - (ii) IT-2: FC 258 and SF 85, Questionnaire for Non-Sensitive Positions; and
  - (iii) IT-3: NASA Form 531, Name Check, and FC 258.
- (4) The Contracting Officer may allow the Contractor to conduct its own screening of individuals requiring privileged access or limited privileged access provided the Contractor can demonstrate that the procedures used by the Contractor are equivalent to NASA's personnel screening procedures. As used here, equivalent includes a check for criminal history, as would be conducted by NASA, and completion of a questionnaire covering the same information as would be required by NASA.
- (5) Screening of Contractor personnel may be waived by the Contracting Officer for those individuals who have proof of –

- (i) Current or recent national security clearances (within last three years);
  - (ii) Screening conducted by NASA within last three years; or
  - (iii) Screening conducted by the Contractor, within last the three years, that is equivalent to the NASA personnel screening procedures as approved by the Contracting Officer under paragraph (d )(4) of this clause.
- e) The Contractor shall ensure that its employees, in performance of the contract, receive annual IT security training in NASA IT Security policies, procedures, computer ethics, and best practices in accordance with NPR 2810.1, Section 4.3 requirements. The Contractor may use web-based training available from NASA to meet this requirement.
- f) The Contractor shall afford NASA, including the Office of Inspector General, access to the Contractor's and subcontractors' facilities, installations, operations, documentation, databases and personnel used in performance of the contract. Access shall be provided to the extent required to carry out a program of IT inspection, investigation and audit to safeguard against threats and hazards to the integrity, availability and confidentiality of NASA data or to the function of computer systems operated on behalf of NASA, and to preserve evidence of computer crime.
- g) The Contractor shall incorporate the substance of this clause in all subcontracts that meet the conditions in paragraph (a) of this clause.

(End of clause)

**I.5 OMBUDSMAN (NASA 1852.215-84) (OCT 2003)**

- (a) An ombudsman has been appointed to hear and facilitate the resolution of concerns from offerors, potential offerors, and Contractors during the preaward and postaward phases of this acquisition. When requested, the ombudsman will maintain strict confidentiality as to the source of the concern. The existence of the ombudsman is not to diminish the authority of the contracting officer, the Source Evaluation Board, or the selection official. Further, the ombudsman does not participate in the evaluation of proposals, the source selection process, or the adjudication of formal contract disputes. Therefore, before consulting with an ombudsman, interested parties must first address their concerns, issues, disagreements, and/or recommendations to the contracting officer for resolution.
- (b) If resolution cannot be made by the contracting officer, interested parties may contact the installation ombudsman, Randy K. Gish, Attn: Mail Code AC, 2101 NASA Parkway, Houston, TX 77058, 281-483-0490, facsimile 281-483-2200, email: randy.k.gish@nasa.gov.

(End of clause)

**(ALT I) (JUN 2000) (Only applicable to IDIQ Task Orders)**

- (c) If this is a task or delivery order contract, the ombudsman shall review complaints from Contractors and ensure they are afforded a fair opportunity to be considered, consistent with the procedures of the contract.

(End of clause)

**I.6 ORDERING (52.216-18) (OCT 1995) (Only applicable to IDIQ Task Orders)**

- (a) Any supplies and services to be furnished under this contract shall be ordered by issuance of delivery orders or task orders by the individuals or activities designated in the Schedule. Such orders may be issued from Contract Start Date through September 7, 2011.
- (b) All delivery orders or task orders are subject to the terms and conditions of this contract. In the event of conflict between a delivery order or task order and this contract, the contract shall control.
- (c) If mailed, a delivery order or task order is considered "issued" when the Government deposits the order in the mail. Orders may be issued orally, by facsimile, or by electronic commerce methods only if authorized in the Schedule.

(End of clause)

**I.7 ORDER LIMITATIONS (52.216-19) (OCT 1995) (Only applicable to IDIQ Task Orders)**

- (a) Minimum order. When the Government requires supplies or services covered by this contract in an amount of less than \$50,000 the Government is not obligated to purchase, nor is the Contractor obligated to furnish, those supplies or services under the contract.
- (b) Maximum order. The Contractor is not obligated to honor-
  - (1) Any order for a single item in excess of \$750,000,000
  - (2) Any order for a combination of items in excess of \$750,000,000 ; or
  - (3) A series of orders from the same ordering office within 5 business days that together call for quantities exceeding the limitation in paragraph (b)(1) or (2) of this section.
- (c) If this is a requirements contract (i.e., includes the Requirements clause at subsection 52.216-21 of the Federal Acquisition Regulation (FAR)), the Government is not required to order a part of any one requirement from the Contractor if that requirement exceeds the maximum-order limitations in paragraph (b) of this section.
- (d) Notwithstanding paragraphs (b) and (c) of this section, the Contractor shall honor any order exceeding the maximum order limitations in paragraph (b), unless that order (or orders) is returned to the ordering office within 5 business days after issuance, with written notice stating the Contractor's intent not to ship the item (or items) called for and the reasons. Upon receiving this notice, the Government may acquire the supplies or services from another source.

(End of clause)

**I.8 INDEFINITE QUANTITY (52.216-22) (OCT 1995) (Only applicable to IDIQ Task Orders)**

- (a) This is an indefinite-quantity contract for the supplies or services specified, and effective for the period stated, in the Schedule. The quantities of supplies and services specified in the Schedule are estimates only and are not purchased by this contract.
- (b) Delivery or performance shall be made only as authorized by orders issued in accordance with the Ordering clause. The Contractor shall furnish to the Government, when and if ordered, the supplies or services specified in the Schedule up to and including the quantity designated in the Schedule as the "maximum." The Government shall order at least the quantity of supplies or services designated in the Schedule as the "minimum."
- (c) Except for any limitations on quantities in the Order Limitations clause or in the Schedule, there is no limit on the number of orders that may be issued. The Government may issue orders requiring delivery to multiple destinations or performance at multiple locations.
- (d) Any order issued during the effective period of this contract and not completed within that period shall be completed by the Contractor within the time specified in the order. The contract shall govern the Contractor's and Government's rights and obligations with respect to that order to the same extent as if the order were completed during the contract's effective period; provided, that the Contractor shall not be required to make any deliveries beyond 12 months after contract period of performance identified in ordering period identified in I.6 "Ordering".

(End of clause)

**I.9 PAYMENT FOR OVERTIME PREMIUMS (FAR 52.222-2) (JUL 1990)**

- (a) The use of overtime is authorized under this contract if the overtime premium does not exceed \$ 0 or the overtime premium is paid for work-
  - (1) Necessary to cope with emergencies such as those resulting from accidents, natural disasters, breakdowns of production equipment, or occasional production bottlenecks of a sporadic nature;
  - (2) By indirect-labor employees such as those performing duties in connection with administration, protection, transportation, maintenance, standby plant protection, operation of utilities, or accounting;
  - (3) To perform tests, industrial processes, laboratory procedures, loading or unloading of transportation conveyances, and operations in flight or afloat that are continuous in nature and cannot reasonably be interrupted or completed otherwise; or
  - (4) That will result in lower overall costs to the Government.
- (b) Any request for estimated overtime premiums that exceeds the amount specified above shall include all estimated overtime for contract completion and shall-
  - (1) Identify the work unit; e.g., department or section in which the requested overtime will be used, together with present workload, staffing, and other data of the affected unit sufficient to permit the Contracting Officer to evaluate the necessity for the overtime;

- (2) Demonstrate the effect that denial of the request will have on the contract delivery or performance schedule;
- (3) Identify the extent to which approval of overtime would affect the performance or payments in connection with other Government contracts, together with identification of each affected contract; and
- (4) Provide reasons why the required work cannot be performed by using multishift operations or by employing additional personnel.

(End of clause)

**L10 RIGHTS IN DATA-GENERAL (FAR 52.227-14) (JUN 1987) as modified by NASA FAR Supplement 1852.227-14, includes 52.227-14 ALT II (JUN 1987) (insertion of (g)(2), ALT III (JUN 1987) (insertion of (g)(3)(i), and ALT V (JUN 1987) (insertion of (j)).**

*(a) Definitions.*

"Computer software," as used in this clause, means computer programs, computer data bases, and documentation thereof.

"Data," as used in this clause, means recorded information, regardless of form or the media on which it may be recorded. The term includes technical data and computer software. The term does not include information incidental to contract administration, such as financial, administrative, cost or pricing, or management information.

"Form, fit, and function data," as used in this clause, means data relating to items, components, or processes that are sufficient to enable physical and functional interchangeability, as well as data identifying source, size, configuration, mating, and attachment characteristics, functional characteristics, and performance requirements; except that for computer software it means data identifying source, functional characteristics, and performance requirements but specifically excludes the source code, algorithm, process, formulae, and flow charts of the software.

"Limited rights," as used in this clause, means the rights of the Government in limited rights data as set forth in the Limited Rights Notice of paragraph (g)(2) if included in this clause.

"Limited rights data," as used in this clause, means data (other than computer software) that embody trade secrets or are commercial or financial and confidential or privileged, to the extent that such data pertain to items, components, or processes developed at private expense, including minor modifications thereof.

"Restricted computer software," as used in this clause, means computer software developed at private expense and that is a trade secret; is commercial or financial and is confidential or privileged; or is published copyrighted computer software, including minor modifications of such computer software.

"Restricted rights," as used in this clause, means the rights of the Government in restricted computer software, as set forth in a Restricted Rights Notice of paragraph (g)(3) if included in this clause, or as



otherwise may be provided in a collateral agreement incorporated in and made part of this contract, including minor modifications of such computer software.

"Technical data," as used in this clause, means data (other than computer software) which are of a scientific or technical nature.

"Unlimited rights," as used in this clause, means the right of the Government to use, disclose, reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, in any manner and for any purpose, and to have or permit others to do so.

*(b) Allocation of rights.*

(1) Except as provided in paragraph (c) of this clause regarding copyright, the Government shall have unlimited rights in-

(i) Data first produced in the performance of this contract;

(ii) Form, fit, and function data delivered under this contract;

(iii) Data delivered under this contract (except for restricted computer software) that constitute manuals or instructional and training material for installation, operation, or routine maintenance and repair of items, components, or processes delivered or furnished for use under this contract; and

(iv) All other data delivered under this contract unless provided otherwise for limited rights data or restricted computer software in accordance with paragraph (g) of this clause.

(2) The Contractor shall have the right to-

(i) Use, release to others, reproduce, distribute, or publish any data first produced or specifically used by the Contractor in the performance of this contract, unless provided otherwise in paragraph (d) of this clause;

(ii) Protect from unauthorized disclosure and use those data which are limited rights data or restricted computer software to the extent provided in paragraph (g) of this clause;

(iii) Substantiate use of, add or correct limited rights, restricted rights, or copyright notices and to take other appropriate action, in accordance with paragraphs (e) and (f) of this clause; and

(iv) Establish claim to copyright subsisting in data first produced in the performance of this contract to the extent provided in paragraph (c)(1) of this clause.

*(c) Copyright-*

(1) Data first produced in the performance of this contract. Unless provided otherwise in paragraph (d) of this clause, the Contractor may establish, without prior approval of the Contracting Officer, claim to copyright subsisting in scientific and technical articles based on or containing

data first produced in the performance of this contract and published in academic, technical or professional journals, symposia proceedings or similar works. The prior, express written permission of the Contracting Officer is required to establish claim to copyright subsisting in all other data first produced in the performance of this contract. When claim to copyright is made, the Contractor shall affix the applicable copyright notices of 17 U.S.C. 401 or 402 and acknowledgment of Government sponsorship (including contract number) to the data when such data are delivered to the Government, as well as when the data are published or deposited for registration as a published work in the U.S. Copyright Office. For data other than computer software the Contractor grants to the Government, and others acting on its behalf, a paid-up, nonexclusive, irrevocable worldwide license in such copyrighted data to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the Government. For computer software, the Contractor grants to the Government and others acting in its behalf, a paid-up nonexclusive, irrevocable worldwide license in such copyrighted computer software to reproduce, prepare derivative works, and perform publicly and display publicly by or on behalf of the Government.

(2) Data not first produced in the performance of this contract. The Contractor shall not, without prior written permission of the Contracting Officer, incorporate in data delivered under this contract any data not first produced in the performance of this contract and which contains the copyright notice of 17 U.S.C. 401 or 402, unless the Contractor identifies such data and grants to the Government, or acquires on its behalf, a license of the same scope as set forth in paragraph (c)(1) of this clause; provided, however, that if such data are computer software the Government shall acquire a copyright license as set forth in paragraph (g)(3) of this clause if included in this contract or as otherwise may be provided in a collateral agreement incorporated in or made part of this contract.

(3) Removal of copyright notices. The Government agrees not to remove any copyright notices placed on data pursuant to this paragraph (c), and to include such notices on all reproductions of the data.

(d) Release, publication and use of data

(1) The Contractor shall have the right to use, release to others, reproduce, distribute, or publish any data first produced or specifically used by the Contractor in the performance of this contract, except to the extent such data may be subject to the Federal export control or national security laws or regulations, or unless otherwise provided in this paragraph of this clause or expressly set forth in this contract.

(2) The Contractor agrees that to the extent it receives or is given access to data necessary for the performance of this contract which contain restrictive markings, the Contractor shall treat the data in accordance with such markings unless otherwise specifically authorized in writing by the Contracting Officer.

(e) Unauthorized marking of data.

- (1) Notwithstanding any other provisions of this contract concerning inspection or acceptance, if any data delivered under this contract are marked with the notices specified in paragraph (g)(2) or (g)(3) of this clause and use of such is not authorized by this clause, or if such data bears any other restrictive or limiting markings not authorized by this contract, the Contracting Officer may at any time either return the data to the Contractor, or cancel or ignore the markings. However, the following procedures shall apply prior to canceling or ignoring the markings.
  - (i) The Contracting Officer shall make written inquiry to the Contractor affording the Contractor 30 days from receipt of the inquiry to provide written justification to substantiate the propriety of the markings;
  - (ii) If the Contractor fails to respond or fails to provide written justification to substantiate the propriety of the markings within the 30-day period (or a longer time not exceeding 90 days approved in writing by the Contracting Officer for good cause shown), the Government shall have the right to cancel or ignore the markings at any time after said period and the data will no longer be made subject to any disclosure prohibitions.
  - (iii) If the Contractor provides written justification to substantiate the propriety of the markings within the period set in subdivision (e)(1)(i) of this clause, the Contracting Officer shall consider such written justification and determine whether or not the markings are to be cancelled or ignored. If the Contracting Officer determines that the markings are authorized, the Contractor shall be so notified in writing. If the Contracting Officer determines, with concurrence of the head of the contracting activity, that the markings are not authorized, the Contracting Officer shall furnish the Contractor a written determination, which determination shall become the final agency decision regarding the appropriateness of the markings unless the Contractor files suit in a court of competent jurisdiction within 90 days of receipt of the Contracting Officer's decision. The Government shall continue to abide by the markings under this subdivision (e)(1)(iii) until final resolution of the matter either by the Contracting Officer's determination becoming final (in which instance the Government shall thereafter have the right to cancel or ignore the markings at any time and the data will no longer be made subject to any disclosure prohibitions), or by final disposition of the matter by court decision if suit is filed.
- (2) The time limits in the procedures set forth in paragraph (e)(1) of this clause may be modified in accordance with agency regulations implementing the Freedom of Information Act (5 U.S.C. 552) if necessary to respond to a request thereunder.
- (3) This paragraph (e) does not apply if this contract is for a major system or for support of a major system by a civilian agency other than NASA and the U.S. Coast Guard agency subject to the provisions of Title III of the Federal Property and Administrative Services Act of 1949.
- (4) Except to the extent the Government's action occurs as the result of final disposition of the matter by a court of competent jurisdiction, the Contractor is not precluded by this paragraph (e) from bringing a claim under the Contract Disputes Act, including pursuant to the Disputes clause of this contract, as applicable, that may arise as the result of the Government removing or ignoring authorized markings on data delivered under this contract.

(f) Omitted or incorrect markings.

- (1) Data delivered to the Government without either the limited rights or restricted rights notice as authorized by paragraph (g) of this clause, or the copyright notice required by paragraph (c) of this clause, shall be deemed to have been furnished with unlimited rights, and the Government assumes no liability for the disclosure, use, or reproduction of such data. However, to the extent the data has not been disclosed without restriction outside the Government, the Contractor may request, within 6 months (or a longer time approved by the Contracting Officer for good cause shown) after delivery of such data, permission to have notices placed on qualifying data at the Contractor's expense, and the Contracting Officer may agree to do so if the Contractor-
  - (i) Identifies the data to which the omitted notice is to be applied;
  - (ii) Demonstrates that the omission of the notice was inadvertent;
  - (iii) Establishes that the use of the proposed notice is authorized; and
  - (iv) Acknowledges that the Government has no liability with respect to the disclosure, use, or reproduction of any such data made prior to the addition of the notice or resulting from the omission of the notice.
- (2) The Contracting Officer may also (i) permit correction at the Contractor's expense of incorrect notices if the Contractor identifies the data on which correction of the notice is to be made, and demonstrates that the correct notice is authorized, or (ii) correct any incorrect notices.

(g) Protection of limited rights data and restricted computer software.

- (1) When data other than that listed in subdivisions (b)(1)(i), (ii), and (iii) of this clause are specified to be delivered under this contract and qualify as either limited rights data or restricted computer software, if the Contractor desires to continue protection of such data, the Contractor shall withhold such data and not furnish them to the Government under this contract. As a condition to this withholding, the Contractor shall identify the data being withheld and furnish form, fit, and function data in lieu thereof. Limited rights data that are formatted as a computer data base for delivery to the Government are to be treated as limited rights data and not restricted computer software.
- (2) Notwithstanding paragraph (g)(1) of this clause, the contract may identify and specify the delivery of limited rights data, or the Contracting Officer may require by written request the delivery of limited rights data that has been withheld or would otherwise be withholdable. If delivery of such data is so required, the Contractor may affix the following "Limited Rights Notice" to the data and the Government will thereafter treat the data, subject to the provisions of paragraphs (e) and (f) of this clause, in accordance with such Notice:

**Limited Rights Notice (June 1987)**

- (a) These data are submitted with limited rights under Government Contract No. (and subcontract, if appropriate). These data may be reproduced and used by the Government with the express limitation that they will not, without written permission of the Contractor, be used for purposes of manufacture nor disclosed outside the Government; except that the Government may disclose these data outside the Government for the following purposes, if any; provided that the Government makes such disclosure subject to prohibition against further use and disclosure:
- (1) Use (except for manufacture) by support service Contractors.
  - (2) Evaluation by nongovernment evaluators.
  - (3) Use (except for manufacture) by other Contractors participating in the Government's program of which the specific contract is a part, for information and use in connection with the work performed under each contract.
  - (4) Emergency repair or overhaul work.
  - (5) Release to a foreign government, or instrumentality thereof, as the interests of the United States Government may require, for information or evaluation, or for emergency repair or overhaul work by such government.
- (b) This Notice shall be marked on any reproduction of these data, in whole or in part.

**(End of notice)**

- (3) (i) Notwithstanding paragraph (g)(1) of this clause, the contract may identify and specify the delivery of restricted computer software, or the Contracting Officer may require by written request the delivery of restricted computer software that has been withheld or would otherwise be withholdable. If delivery of such computer software is so required, the Contractor may affix the following "Restricted Rights Notice" to the computer software and the Government will thereafter treat the computer software, subject to paragraphs (e) and (f) of this clause, in accordance with the Notice:

**Restricted Rights Notice (June 1987)**

- (a) This computer software is submitted with restricted rights under Government Contract No. \_\_\_\_\_ (and subcontract, if appropriate). It may not be used, reproduced, or disclosed by the Government except as provided in paragraph (b) of this Notice or as otherwise expressly stated in the contract.
- (b) This computer software may be-
- (1) Used or copied for use in or with the computer or computers for which it was acquired, including use at any Government installation to which such computer or computers may be transferred;

- (2) Used or copied for use in a backup computer if any computer for which it was acquired is inoperative;
  - (3) Reproduced for safekeeping (archives) or backup purposes;
  - (4) Modified, adapted, or combined with other computer software, provided that the modified, combined, or adapted portions of the derivative software incorporating restricted computer software are made subject to the same restricted rights;
  - (5) Disclosed to and reproduced for use by support service Contractors in accordance with paragraphs (b)(1) through (4) of this clause, provided the Government makes such disclosure or reproduction subject to these restricted rights; and
  - (6) Used or copied for use in or transferred to a replacement computer.
- (c) Notwithstanding the foregoing, if this computer software is published copyrighted computer software, it is licensed to the Government, without disclosure prohibitions, with the minimum rights set forth in paragraph (b) of this clause.
- (d) Any other rights or limitations regarding the use, duplication, or disclosure of this computer software are to be expressly stated in, or incorporated in, the contract.
- (e) This Notice shall be marked on any reproduction of this computer software, in whole or in part.

**(End of notice)**

- (ii) Where it is impractical to include the Restricted Rights Notice on restricted computer software, the following short-form Notice may be used in lieu thereof:

**Restricted Rights Notice Short Form (June 1987)**

Use, reproduction, or disclosure is subject to restrictions set forth in Contract No. (and subcontract, if appropriate) with (name of Contractor and subcontractor).

**(End of notice)**

- (iii) If restricted computer software is delivered with the copyright notice of 17 U.S.C. 401, it will be presumed to be published copyrighted computer software licensed to the Government without disclosure prohibitions, with the minimum rights set forth in paragraph (b) of this clause, unless the Contractor includes the following statement with such copyright notice: "Unpublished-rights reserved under the Copyright Laws of the United States."
- (h) **Subcontracting.** The Contractor has the responsibility to obtain from its subcontractors all data and rights therein necessary to fulfill the Contractor's obligations to the Government under this contract. If a subcontractor refuses to accept terms affording the Government such rights, the Contractor shall

promptly bring such refusal to the attention of the Contracting Officer and not proceed with subcontract award without further authorization.

- (i) Relationship to patents. Nothing contained in this clause shall imply a license to the Government under any patent or be construed as affecting the scope of any license or other right otherwise granted to the Government.
- (j) The Contractor agrees, except as may be otherwise specified in this contract for specific data items listed as not subject to this paragraph, that the Contracting Officer or an authorized representative may, up to three years after acceptance of all items to be delivered under this contract, inspect at the Contractor's facility any data withheld pursuant to paragraph (g)(1) of this clause, for purposes of verifying the Contractor's assertion pertaining to the limited rights or restricted rights status of the data or for evaluating work performance. Where the Contractor whose data are to be inspected demonstrates to the Contracting Officer that there would be a possible conflict of interest if the inspection were made by a particular representative, the Contracting Officer shall designate an alternate inspector.

(End of clause)

**I.11 RIGHTS TO PROPOSAL DATA (TECHNICAL) (FAR 52.227-23) (JUN 1987)**

Except for data contained in Volumes I through VII, including any Addendums, Amendments or Revisions thereto that are marked with the legend "LOCKHEED MARTIN PROPRIETARY INFORMATION", it is agreed that as a condition of award of this contract, and notwithstanding the conditions of any notice appearing thereon, the Government shall have unlimited rights (as defined in the "Rights in Data-General" clause contained in this contract) in and to the technical data contained in the proposals dated 20 March 2006, 20 April 2006, 21 July 2006 and 28 July 2006 upon which this contract is based.

(End of clause)

**I.12 EARNED VALUE MANAGEMENT SYSTEM (MARCH 1999) (Deviation)**

(a) In the performance of this contract, the Contractor shall use an earned value management system (EVMS) that has been recognized by the cognizant Administrative Contracting Officer (ACO) as complying with the guidelines specified in ANSI/EIA Standard 748, Industry Guidelines for Earned Value Management Systems.

(b) If, at the time of award, the Contractor's EVMS has not been recognized by the ACO as complying with the EVMS guidelines, the Contractor shall apply the system to the contract and shall take timely action to implement its plan to obtain compliance. The Contractor shall follow and implement the approved compliance plan in a timely fashion. The Government will conduct a Compliance Review to assess the contractor's compliance with its plan, and if the Contractor does not follow the approved implementation schedule or correct all resulting system deficiencies identified as a result of the compliance review within a reasonable time, the Contracting Officer may take remedial action, that may include, but is not limited to, a reduction in fee.

(c) The Government will require integrated baseline reviews. Such reviews shall be scheduled as early as practicable and should be conducted within 180 calendar days after contract award or exercise of significant contract options; or within two months after distribution of a supplemental agreement that implemented a significant funding realignment or effected a significant change in contract requirements. The objective of IBRs is for the Government and the Contractor to jointly assess the Contractor's baseline to be used for performance measurement to ensure complete coverage of the statement of work, logical scheduling of the work activities, adequate resourcing, and identification of inherent risks.

(d) Unless a waiver is granted by the ACO, Contractor proposed EVMS changes require approval of the ACO prior to implementation. The ACO shall advise the Contractor of the acceptability of such changes within 30 calendar days after receipt of the notice of proposed changes from the Contractor. If the advance approval requirements are waived by the ACO, the Contractor shall disclose EVMS changes to the ACO and provide an information copy to the NASA Contracting Officer at least 14 calendar days prior to the effective date of implementation.

(e) The Contractor agrees to provide access to all pertinent records and data requested by the ACO or a duly authorized representative. Access is to permit Government surveillance to ensure that the EVMS complies, and continues to comply, with the criteria referenced in paragraph (a) of this clause.

(f) The Contractor shall be responsible for ensuring that the subcontractors identified below to comply with the EVMS requirements at the specified level. If the subcontractor does not have an EVMS that has been recognized by the ACO as compliant with ANSI/EIA 748, the prime contractor shall conduct Compliance Reviews of subcontractors' EVMS in the same manner as described at paragraph (b) of this clause. (Insert list of applicable subcontractors and the level of compliance (i.e., guidelines or principles).)

(g) If the contractor identifies a need to deviate from the agreed baseline by working against an Over Target Baseline or Over Target Schedule, the contractor shall submit to the Contracting Officer a request for approval to begin implementation of an Over Target Baseline or Over Target Schedule. This request shall include a top-level projection of cost and/or schedule growth, whether or not performance variances will be retained, and a schedule of implementation for the rebaselining. The Government will authorize or deny the request within 30 calendar days after receipt of the request. Failure of the Government to respond within this 30-day period constitutes approval of the request. For cost-reimbursement contracts, the contract budget baseline shall exclude changes for cost growth increases, other than for authorized changes to the contract requirements.

(End of clause)

### **I.13 ENGINEERING CHANGE PROPOSALS (NASA 1852.243-70) (OCT 2001)**

(a) Definitions.

"ECP" means an Engineering Change Proposal (ECP), which is a proposed engineering change and the documentation by which the change is described, justified, and submitted to the procuring activity for approval or disapproval.



- (b) Either party to the contract may originate ECPs. Implementation of an approved ECP may occur by either a supplemental agreement or, if appropriate, as a written change order to the contract.
- (c) Any ECP submitted to the Contracting Officer shall include a "not-to-exceed" price increase or decrease adjustment amount, if any, and the required time of delivery adjustment, if any, acceptable to the originator of the ECP. If the change is originated within the Government, the Contracting Officer shall obtain a written agreement with the Contractor regarding the "not-to-exceed" price and time of delivery adjustments, if any, prior to issuing an order for implementation of the change.
- (d) After submission of a Contractor initiated ECP, the contracting officer may require the Contractor to submit the following information:
  - (1) Cost or pricing data in accordance with FAR 15.403-5 if the proposed change meets the criteria for its submission under FAR 15.403-4; or
  - (2) Information other than cost or pricing data adequate for contracting officer determination of price reasonableness or cost realism. The contracting officer reserves the right to request additional information if that provided by the Contractor is considered inadequate for that purpose. If the Contractor claims applicability of one of the exceptions to submission of cost or pricing data, it shall cite the exception and provide rationale for its applicability.
- (e) If the ECP is initiated by NASA, the contracting officer shall specify the cost information requirements, if any.

**ALTERNATE II  
(SEP 1990)**

An ECP accepted in accordance with the Changes clause of this contract shall not be considered an authorization to the Contractor to exceed the estimated cost in the contract Schedule, unless the estimated cost is increased by the change order or other contract modification.

(End of clause)

**I.14 SUBMISSION OF COMMERCIAL TRANSPORTATION BILLS TO THE GENERAL SERVICES ADMINISTRATION FOR AUDIT (FAR 52.247-67) (JUN 1997)**

- (a)(1) In accordance with paragraph (a)(2) of this clause, the Contractor shall submit to the General Services Administration (GSA) for audit, legible copies of all paid freight bills/invoices, commercial bills of lading (CBL's), passenger coupons, and other supporting documents for transportation services on which the United States will assume freight charges that were paid-
  - (i) By the Contractor under a cost-reimbursement contract; and
  - (ii) By a first-tier subcontractor under a cost-reimbursement subcontract hereunder.
- (2) Cost-reimbursement Contractors shall only submit for audit those CBL's with freight shipment charges exceeding \$50.00. Bills under \$50.00 shall be retained on-site by the Contractor and made available for GSA on-site audits. This exception only applies to freight shipment bills and is not intended to apply to bills and invoices for any other transportation services.
- (b) The Contractor shall forward copies of paid freight bills/invoices, CBL's, passenger coupons, and supporting documents as soon as possible following the end of the month, in one package to the:

General Services Administration  
Attn: FWA  
1800 F. Street, NW  
Washington, DC 20405

The Contractor shall include the paid freight bills/invoices, CBL's, passenger coupons, and supporting documents for first-tier subcontractors under a cost-reimbursement contract. If the inclusion of the paid freight bills/invoices, CBL's, passenger coupons, and supporting documents for any subcontractor in the shipment is not practicable, the documents may be forwarded to GSA in a separate package.

- (c) Any original transportation bills or other documents requested by GSA shall be forwarded promptly by the Contractor to GSA. The Contractor shall ensure that the name of the contracting agency is stamped or written on the face of the bill before sending it to GSA.
- (d) A statement prepared in duplicate by the Contractor shall accompany each shipment of transportation documents. GSA will acknowledge receipt of the shipment by signing and returning the copy of the statement. The statement shall show-
- (1) The name and address of the Contractor;
  - (2) The contract number including any alpha-numeric prefix identifying the contracting office;
  - (3) The name and address of the contracting office;
  - (4) The total number of bills submitted with the statement; and
  - (5) A listing of the respective amounts paid or, in lieu of such listing, an adding machine tape of the amounts paid showing the Contractor's voucher or check numbers.

(End of clause)

**I.15 CLAUSES INCORPORATED BY REFERENCE (FAR 52.252-2) (FEB 1998)**

This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. Also, the full text of a clause may be accessed electronically at these addresses:

<http://www.arnet.gov/far/>

<http://www.hq.nasa.gov/office/procurement/regs/nfstoc.htm>

(End of clause)

**I.16 AUTHORIZED DEVIATIONS IN CLAUSES (FAR 52.252-6) (APR 1984)**

- (a) The use in this solicitation or contract of any Federal Acquisition Regulation (48 CFR Chapter 1) clause with an authorized deviation is indicated by the addition of "(DEVIATION)" after the date of the clause.
- (b) The use in this solicitation or contract of any NASA (48 CFR Chapter 18) clause with an authorized deviation is indicated by the addition of "(DEVIATION)" after the name of the regulation.

(End of clause)

(END OF SECTION)

## **ATTACHMENT J-1**

## **STATEMENT OF WORK**

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## ***INTRODUCTION***

The Crew Exploration Vehicle (CEV) is the spacecraft that NASA plans to use to send human and cargo items into space and to return them to earth. The CEV is an element of the overall Constellation Program that includes launch vehicles, spacecraft, and ground systems needed to embark on a robust space exploration program. This space exploration program will advance the Nation's scientific, security, and economic interests.

## ***Scope***

The Contractor will develop and certify the CEV System to meet the lunar mission requirements, where the CEV is used to carry the crew to low earth orbit (LEO) for rendezvous with other elements for the lunar missions and also serve as the return-to-earth vehicle for the crew. The Contractor will modify and certify this CEV as required to support ISS mission requirements for crewed and pressurized cargo configurations. The Contractor will deliver the CEV spacecraft configurations below per requirements in the CXP-10001, System Requirements for the Crew Exploration Vehicle Element (CEV SRD).

The following more clearly defines the different configuration variants of the CEV Spacecraft:

1. Block 1A is a crewed, pressurized vehicle for Low Earth Orbit (LEO) (including ISS crew change out) missions. This configuration includes:

- A habitable Crew Module (CM)
- A Service Module (SM)
- A Launch Abort System (LAS) to provide a method for crew abort
- A Spacecraft Adapter (SA) to provide connection to the Crew Launch Vehicle (CLV)

2. Block 1B is an uninhabited, pressurized vehicle for ISS resupply missions. It uses an SM, an uninhabited CM, and an SA.

3. Block 2 is a crewed, pressurized vehicle for lunar missions. It uses a habitable CM, LAS, SM, and SA to support lunar missions.

Both Constellation Program CXP-00003, Constellation Architecture Common Glossary and Acronym List, and Attachment J-5, Glossary, provide a detailed listing of terms used in this Statement of Work.

## ***CEV Implementation Strategy***

The CEV implementation strategy requires a detailed implementation schedule to design the spacecraft, and implement, certify, and deliver it. NASA will work closely with the Contractor to develop the details of an implementation strategy that maintains the highest standards for safety, reliability, and mission assurance. Ways that NASA will work closely with the Contractor include the following: NASA will participate in daily management and design meetings and decisions, NASA will work with the Contractor on the shop floor during development, NASA will have a rapid Material Review Board (MRB) process in order to help prevent stop-work conditions, and NASA will work with the Contractor in the test facilities during integration and test activities. The purpose of the level of participation is for access to NASA for timely decisions.

NASA will provide the detailed oversight of all spacecraft design activities. However, the Contractor will retain responsibility for delivery of a design that meets the requirements. The

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detailed process discussion to accomplish this can be found in CXP-12000, NASA CEV Project Management Plan (PM-0001). Some areas of spacecraft design will be provided by NASA and NASA will perform independent activities for requirements validation and design certification in other areas. In these areas NASA will establish design requirements teams to integrate the activities of NASA and the Contractor. The Contractor will participate in and support these design requirements teams.

The Contractor will deliver a design that ensures simplicity, minimizes life cycle cost and addresses all aspects of human spacecraft development, production, certification and operations. The Contractor will design, develop, certify, and deliver the hardware required to achieve the lunar mission requirements. Requirements for ISS missions are intended to have minimal impact to the subsystem and subsystem component designs, but these must also be included in this effort. The concept is to develop a "common" design for the spacecraft variants, where the vehicle will meet both Lunar and ISS requirements. The common design and life cycle approaches will lead to an effective implementation of subsystem and spacecraft deliveries.

The Contractor is expected to develop and verify ISS mission software during Schedule A, but not lunar mission software. However, lunar mission software requirements must be evaluated to ensure the command and data handling hardware can accommodate the additional software required for lunar missions, as well as other mission objectives. NASA strategy includes flight software sustaining engineering, coupled with vehicle upgrades, to achieve lunar mission objectives.

NASA will perform the CEV ground, flight, and training operations; design and develop CEV ground operations facilities, facility systems, and NASA-provided ground support equipment (GSE); and provide high-fidelity simulators and trainers. Further, NASA will conduct flight testing to demonstrate vehicle performance characteristics. NASA will lead a joint NASA and Contractor Combined Test Team (CTT) that consists of representatives from all participating test organizations. In support of the NASA operations, risk reduction flight testing, and safety and mission assurance activities, the Contractor must provide the necessary data products and expertise as detailed in the SOW.

NASA will use the technical Data Requirements Documents (DRDs) to sustain and operate the CEV over the life of the Project. It is NASA's intent to use the technical DRDs to document the CEV requirements, design, and certification activities.

## ***Contract Structure***

To help differentiate the type of activities that comprise the Phase 2 contract, NASA has developed multiple "schedules." These include:

1. Schedule A (DDT&E) from 2006-2013. This includes production of the first actual flight module of the 1A and 1B variants, along with other deliverables described in Section 6.5. Schedule A incorporates both completion form and indefinite delivery, indefinite quantity (IDIQ) paragraphs. All paragraphs are completion form unless specifically marked as "IDIQ."
2. Schedule B (Production) from 2009-2019. This includes production of all block variants following first flight of each specific variant.
3. Schedule C (Sustaining Engineering) from 2009-2019. This includes any new DDT&E effort required beyond the scope of Schedule A, such as the Block 2 variant.

This statement of work applies to Schedule A only. Descriptions of other contract schedules are provided for reference only.



# **1 PROJECT MANAGEMENT**

The Contractor shall develop, implement and maintain a set of common project management processes, systems and data deliverables to be utilized for all contract schedules (A, B and C) throughout the life of the contract.

## **1.1 Project Management and Administration**

An anchoring capability of the Constellation Program is a human-rated CEV that will carry human crews from Earth into space and back again. Coupled with transfer stages, landing vehicles, and surface exploration systems, the CEV will serve as an essential component of the architecture that supports human voyages to ISS, the Moon, and beyond.

- a) The Contractor shall design, develop, certify, and deliver the hardware and software required to achieve the LEO and lunar mission requirements. Requirements for ISS missions (Block 1A and 1B) are intended to have minimal impact to the subsystem and subsystem component designs, but must also be included in this effort. Block 2 changes are envisioned to be software only and shall be accomplished under Schedule C.
- b) The Contractor should minimize life cycle cost in the design, development, certification, and delivery of the hardware and software required to achieve the LEO and lunar mission requirements.
- c) The Contractor shall ensure crew/ground safety while meeting system performance requirements and achieving mission objectives.
- d) The Contractor shall design the CEV System to accommodate all the design reference missions defined in CXP-00002, Constellation Design Reference Missions (DRM).
- e) The Contractor shall design the CEV System to the requirements and terms specified in CXP-10001, System Requirements for the Crew Exploration Vehicle Element (CEV SRD).
- f) The Contractor shall implement designs for the CEV spacecraft and ground systems to achieve efficient and effective operations.
- g) The Contractor shall perform to the negotiated cost, schedule, and technical baseline.
- h) The Contractor shall support a human flight as close to 2010 as possible, but no later than 2012.
- i) The Contractor should maximize the use of existing technology in the design of the CEV, unless new technology is required to meet NASA requirements.
- j) The Contractor shall base the vehicle design on an open system architecture.
- k) The Contractor should qualify components, subsystems, modules, and systems by test, to the maximum extent possible.
- l) The Contractor shall provide a CEV System that shall have a lifecycle that ends no less than 20 years after the first human flight.

### **1.1.1 Project Management, Systems, Planning and Reporting**

- a) The Contractor shall implement an organizational structure for the management, coordination, and control of contract activities including the project's cost, schedule, performance, risks, contracts, and subcontracts using as guidance ISO 14300-1, Space Systems - Programme Management - Part 1: Structuring of a Programme. The Contractor shall develop and implement a project management plan that covers all aspects of project management for the CEV Project in accordance with **DRD CEV-M-001, CEV Prime Project**

Management Plan.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-M-001: CEV Prime Project Management Plan

**1.1.2 Performance Management Reviews and Performance Metrics**

- a) The Contractor shall conduct quarterly Performance Management Reviews (PMRs) with the Crew Exploration Vehicle Project Office (CEVPO) in accordance with **DRD CEV-M-002, Performance Assessment Plan, Reports and Management Reviews**. The reviews shall provide insight into the Contractor's, subcontractors', and vendors' overall technical, schedule, and cost performance and status.
- b) The Contractor shall define the metrics, to be approved by government, in accordance with the **DRD CEV-M-002, Performance Assessment Plan, Reports and Management Reviews**. The Contractor shall update the metrics and performance data monthly and make it available for NASA review in the Contractor's collaborative environment and during working-level discussions. The Contractor shall present the metrics and performance data at the PMRs.
- c) The Contractor shall recommend the technical performance parameters, to be approved by NASA, in the Performance Assessment Plan. The Contractor shall status the technical performance parameters quarterly in their Performance Assessment Reports.
- d) The Contractor shall report on each SOW and SRD "should" statement at the PMR until the "shoulds" are satisfactorily accomplished.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-M-002: Performance Assessment Plan, Reports and Management Reviews

**1.1.3 NASA Integrated Collaborative Environment (ICE)**

The NASA Integrated Collaborative Environment (ICE) is the primary means of sharing, reporting, collecting, recording, and accessing project information between NASA, the CEV Contractor, subcontractors and authorized Government personnel connected with the CEV Project. ICE provides secure, real-time collaborative access to a single source of management information, product information, and technical data. ICE is the principal mechanism for integrating a project's digital information management environment.

- a) The Contractor shall use ICE for delivery of all data.
- b) The Contractor shall use the interactive collaborative configuration management and document management environments of ICE for configuration management of CEV project directives and change control activities.
- c) The Contractor shall comply with Attachment J-14, ICE Operating Environment.
- d) The Contractor shall implement the ICE interface using one of the two options described in J-14, ICE Operating Environment, Section II, Data Access Requirements.
- e) The Contractor's collaborative environment shall be available within 30 days of contract award.

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- f) The Contractor's collaborative environment shall be updated with the latest status information based on the Contractor-determined interval(s) and as approved by NASA.

**1.1.4 Configuration Management**

- a) The Contractor shall develop and implement Configuration Management (CM) processes and systems.
- o The Contractor CM process and system shall use MIL-HDBK-61A, Military Handbook Configuration Management Guidance, as guidance.
  - o The Contractor's CM process and system shall provide the following: (1) configuration identification, (2) configuration control, (3) configuration status accounting, and (4) configuration management verification and audits.
  - o The Contractor CM plan shall define how the *Software Configuration Management Plan* (see **DRD CEV-T-006**) supports this CM process and system.
  - o The Contractor shall work with NASA to develop a configuration management process that also integrates with the Constellation Program and complies with the CXP-02007, Constellation Nomenclature Plan. The Contractor CM process and system will be approved by NASA.
- b) The Contractor shall integrate the CM system across all CEV project elements including modeling and simulation, engineering drawing development and release, manufacturing, test equipment and test articles, operations, and quality, as well as acquisition organizations including customer and vendor CM systems.
- c) The Contractor shall implement and maintain a configuration status accounting system that provides information defining and maintaining the as-designed and as-built configuration of the system hardware and software and the status of changes to this configuration.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-M-003: Configuration Management Plan and Reports

**1.1.5 Data Management**

- a) The Contractor shall develop and implement Data Management (DM) processes and systems.
- o The Contractor's DM process and system shall provide the following: (1) data identification, (2) data control, (3) data status accounting, and (4) data management verification and audits.
  - o The Contractor shall work with NASA to develop a data management process that also integrates with the Constellation Program and complies with CXP-02007, Constellation Nomenclature Plan. The Contractor DM process and system will be approved by NASA.
- b) The Contractor shall integrate the DM system across all CEV project elements such as modeling and simulation, engineering drawing development, manufacturing, test equipment and test articles, operations, and quality, as well as acquisition organizations including customer and vendor DM systems.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-M-004: Data Management Plan

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**1.1.6 Risk Management**

- a) The Contractor shall identify, evaluate, manage, and control the safety, technical, cost, and schedule-related risks associated with all aspects of the CEV Project in accordance with the risk management portion of CXP-12000, NASA CEV Project Management Plan (PM-0001).
- b) The Contractor shall provide substantiating data for each risk identified in accordance with **DRD CEV-M-005, Risk Management Plan and Reports**.
- c) The Contractor shall substantiate each identified risk in the form of historical information, and analysis. These analyses and information may be integrated with Probabilistic Risk Assessment (PRA) analysis, as appropriately applied to high risk hardware/software development and operations. Reference S&MA **DRD CEV-S-010, Probabilistic Risk Assessment Results**.
- d) The Contractor shall communicate and elevate multi-element and external interface risks to the CEV Project office for the purpose of multi-element risk integration.
- e) The Contractor shall perform integrated risk analysis, mitigation, tracking/control for the CEV Project office. This effort is for the purpose of communication of external interface and multi-element risk integration data for the Constellation-level risk management process.
- f) The Contractor shall manage risks utilizing a risk management tool. The Contractor shall integrate their risk management tool with ICE. The NASA CEV project currently uses Active Risk Manager (ARM) as its enterprise architecture tool for risk management.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-M-005: Risk Management Plan and Reports

**1.1.7 Integrated Master Plan (IMP)**

- a) The Contractor shall develop and maintain an Integrated Master Plan (IMP), as Attachment J-15 of this contract, that delineates Schedule A, B and C activities. All changes to the IMP shall be via bilateral modification.
- b) The Contractor shall manage the execution of the CEV System using the IMP. The Contractor shall report on contract progress in accordance with the IMP at each PMR.

**1.1.8 Integrated Master Schedule (IMS)**

- a) The Contractor shall develop, maintain, and provide NASA access to an Integrated Master Schedule (IMS). The Contractor shall use this schedule for day-to-day management of the contract tasks. Reference contract Clause H.12, Electronic Data Access.
- b) The Contractor shall create and maintain a schedule that supports automated time phasing of tasks, and is a resource loaded, predecessor/successor structured, networked schedule, with critical path identification and schedule assessment capability. The Contractor shall incorporate delivery schedules for NASA products and data into their IMS and provide an integrated IMS that reflects the entire CEV project scope.
- c) The Contractor shall maintain and update the IMS to reflect changes in the IMP and deliver it in accordance with Section 13.1 of **DRD CEV-B-003, Cost Performance Report**.
- d) The Contractor shall utilize the IMS as the source for schedule data delivered to NASA.
- e) The Contractor shall integrate all risk mitigation activities into the IMS.

f)

### ***Deliverables***

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-B-003: Cost Performance Report

## **1.1.9 Internal/External Project Review Support**

- a) The Contractor shall develop briefing materials and analyses for CEV System meetings with various internal and external review groups. Examples of these internal and external groups include the flight technique panels, Aerospace Safety Advisory Panel (ASAP), Inspector General/Government Accountability Office (IG/GAO), and cost assessments teams.
- b) The Contractor shall prepare and present various topics, such as CEV Project technical, cost, and schedule status, specific safety or risk issues, design and development issues, and responses to external inquiries, as directed by NASA.

## **1.2 Business Management**

### **1.2.1 Financial Management**

Financial Management provides summary-level cost reporting by fund source, Work Breakdown Structure (WBS), elements of cost and workforce including labor equivalent personnel (EP), overhead, and other direct and indirect costs.

- a) The Contractor shall develop, deliver, and implement monthly financial management reporting in accordance with **DRD CEV-B-001**, *Financial Management Report* (NASA Form 533).
- b) The Contractor shall provide project-wide data once a year to be used in NASA's budget planning process (e.g., program operating plan (POP) budget calls). The Contractor shall provide an annual Operating Plan (OP) update to that data for the upcoming fiscal year as requested by NASA. NASA will specify the format and content of the Contractor's inputs and rationale.
- c) Upon request by NASA, the Contractor shall provide project-wide budget data a maximum of three times per year. This data will be used for the purposes of gathering budget impacts for various re-planning scenarios. NASA will specify the format and content of the Contractor's inputs and rationale.
- d) The Contractor shall provide property financial reports in accordance with **DRD CEV-B-004**, *Property Financial Reporting*.

### ***Deliverables***

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-B-001: Financial Management Report (533)
- DRD CEV-B-004: Property Financial Reporting

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**1.2.2 Workforce Reporting**

Workforce Reporting provides workforce information by geographic location.

- a) The Contractor shall develop, deliver and implement workforce data in accordance with **DRD CEV-B-002, Workforce Reporting**.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-B-002: Workforce Reporting

**1.2.3 Reserved****1.2.4 Integrated Baseline Review (IBR)**

- a) The Contractor shall perform an Integrated Baseline Review (IBR) with NASA to establish the contract baseline within ninety (90) calendar days after receiving Authorization To Proceed (ATP). Subsequent updates may be required by NASA to update the performance measurement baseline. The IBR shall include the following accomplishment criteria:
- Project organization fully established with cost control accounts and organization members identified, including interfaces and interactions with NASA. Organization and teaming roles and responsibilities defined.
  - Organizational staffing plans in place
  - IMS review
  - Risk management system and process review
  - Metrics baselined
  - Earned value management system and process review
- b) The Contractor shall ensure the technical contents of work packages and control accounts are consistent with the scope of work defined in the WBS, SOW and SRD.
- c) The Contractor shall work jointly with NASA to develop and document an integrated performance measurement baseline. This baseline consists of all contract work including the integration of GFE.
- d) NASA will provide agreed-to specific GFE performance measurement baseline data.
- e) The Contractor shall provide a logical, resource-loaded, integrated/interdependent sequence (i.e. predecessor/successor network) of tasks supporting the contract schedule.
- f) The Contractor shall demonstrate to NASA that metric collection methods are in place to monitor agreed-to requirements of the contract.

**1.2.5 Cost Performance Report**

The Cost Performance Report (CPR) will be used to provide information for: (1) integrating cost and schedule performance data with technical performance measures, (2) assessing the magnitude and impact of actual and potential problem areas causing significant cost and schedule variances, and (3) providing valid, timely status information to the CEV Project.

- a) The Contractor shall establish, maintain, and use in the performance of this contract, an integrated earned value management system.

- b) The Contractor will perform earned value analysis per NFS 1852.242-75, and shall capture, maintain, and provide NASA access to the earned value analysis data. The earned value analysis data, at both the cost account and overall project-level, shall be presented as part of the quarterly PMR. Reference **DRD CEV-M-002**, *Performance Assessment Plan, Reports and Management Reviews*.
- c) The Contractor shall develop, deliver and implement CPR data in accordance with **DRD CEV-B-003**, *Cost Performance Report*, and shall support informal working-level discussions on the content.

#### **Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-B-003: Cost Performance Report

### **1.2.6 Life Cycle Cost Management**

- a) The Contractor shall capture, maintain, and provide access to life cycle cost analysis data in the NASA ICE as it evolves through the project life cycle. Life cycle cost definitions to be used in the analysis are defined in Attachment J-5, Appendix 1, Life Cycle Cost Analysis. Life cycle cost analysis data for DDT&E and operability shall be generated and presented at each major design review (e.g. SDR, PDR, CDR) and at each quarterly PMR. These presentations shall include the latest LCC estimate, as well as a detailed discussion of the impact from the current design, design and operations changes since the last review, and the rationale for the changes.

Reference SOW paragraph 2.1.5.a., System Analysis.

## **1.3 External Relationships**

### **1.3.1 Associate Contractors**

- a) The Contractor shall establish cooperative relationships with other Constellation contractors, defined as associate contractor relationships. Associate relationships are required for expeditious exchange of management and technical data among Constellation contractors.

### **1.3.2 NASA Centers**

- a) The Contractor shall establish cooperative relationships at the NASA centers to provide support (e.g. technical analyses, data, etc.) or understand NASA GFE and associated data deliverables (reference SOW paragraph 6.b). schedules, interfaces, and interactions.

These relationships shall be documented in accordance with **DRD CEV-M-001**, *CEV Prime Project Management Plan*.

- b)

## **1.4 Technical Reviews**

- a) The Contractor shall support the planning and execution of technical integration reviews conducted by NASA. The Contractor shall support integrated analysis and assessment efforts

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in support of the integration reviews to identify and resolve integration issues with other Constellation elements, as required.

- b) The reviews conducted by NASA are contained in the Constellation Program Integrated Master Schedule. Major reviews include, at a minimum, the CEV System Design Review, Preliminary Design Review, Critical Design Review, System Acceptance Review, Stage Operations Readiness Review (for missions to the ISS), and Flight Readiness Review. At all reviews, the Contractor shall develop and present data and respond to Review Item Discrepancies (RIDs) and identified CoFR exceptions.

## **1.5 Information Technology Management**

- a) For IT applications, other than mission-specific software, the Contractor shall:
  - o Where cost effective to NASA, use Commercial-Off-The-Shelf (COTS) and existing Government Off-The-Shelf (GOTS) products.
  - o Ensure compatibility with existing NASA applications and systems.
  - o Comply with NASA requirements for NPR 7150.2, NASA Software Engineering Requirements for the appropriate software classes, limited to classes E, F, and G.

## **1.6 Reserved**

## **1.7 Special Studies (IDIQ)**

- a) The Contractor shall perform special CEV-related studies and analyses as directed by NASA. The Contractor shall define the resources required as part of their response to NASA's request for a task order plan. The trade studies and analyses resulting from special studies shall also include the impact to system safety and life cycle cost.



## **2 SYSTEMS ENGINEERING AND INTEGRATION**

### **2.1 Crosscutting Systems Engineering and Integration Development Activities**

#### **2.1.1 Systems Engineering Management**

Systems Engineering Management consists of the efforts to manage the Contractor's systems engineering and integration activities and to manage the Contractor's participation in NASA-led Constellation Program systems engineering and integration activities in accordance with NASA requirements and the Contractor's documented plans.

- a) The Contractor shall manage their systems engineering and integration activities consistent with CXP-12000, NASA CEV Project Management Plan (PM-0001).
- b) The Contractor shall participate in CEV Project and Constellation Program systems engineering and integration activities in accordance with CXP-12000, NASA CEV Project Management Plan (PM-0001).
- c) The Contractor shall implement plans for managing technical data products, processes and organizational roles and responsibilities used to accomplish their systems engineering and integration activities and document their plans in the Contractor's PMP (**DRD CEV-M-001**, CEV Prime Project Management Plan).

#### **2.1.2 Integrated Models and Simulations**

- a) The Contractor shall develop, implement, deliver and maintain a Modeling and Simulation Support Plan in accordance with **DRD CEV-T-001**, *Integrated Models, Simulations and Support Plan*.
- b) The Contractor shall deliver and maintain models supporting discipline-oriented engineering analysis and trade studies in accordance with **DRD CEV-T-002**, *CEV Engineering Models*.
- c) The Contractor shall deliver and maintain a system architecture model and discrete-event simulation to evaluate effectiveness and performance of the vehicle design in accordance with **DRD CEV-T-001**, *Integrated Models, Simulations and Support Plan*.
- d) The Contractor shall deliver and maintain modular, high-fidelity, time-stepped simulations of vehicle behavior for avionics hardware and software integration and test in accordance with the IEEE 1516 (High Level Architecture) standard and **DRD CEV-T-001**, *Integrated Models, Simulations and Support Plan*.
- e) The Contractor shall make available to NASA all Contractor-developed design and analysis tools, models and simulations used in the development of the CEV System, including source code, in accordance with the Electronic Data Access Clause (H.12).
- f) Every tool, model, and simulation delivery shall be accompanied by a meta-data document in accordance with CXP-02017, NEXIOM Standard for Tool, Model and Simulation Deliveries.
- g) The Contractor shall provide the configuration management data for all technical models and drawings to the NASA ICE per **DRD CEV-M-003**, *Configuration Management Plan and Reports*.
- h) The Contractor shall deliver all CAD models per **DRD CEV-T-003**, *CEV CAD Models*, and drawings per **DRD CEV-T-004**, *CEV Drawings*.
- i) The Contractor shall participate in the NASA Integrated Modeling and Simulation (IM&S) Working Group. (IDIQ)

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- j) The Contractor shall participate in the NASA Exploration Information Ontology Model (NEXIOM) Working Group. (IDIQ)
- k) The Contractor shall participate in the NASA Integrated Modeling and Simulation Verification Validation and Accreditation (VV&A) Working Group described in CXP-02018, Modeling and Simulation (M&S) Verification and Validation (V&V) Process Plan and Specification. (IDIQ)
- l) The Contractor shall participate in the Verification, Validation and Accreditation process described in CXP-02018, Modeling and Simulation (M&S) Verification and Validation (V&V) Process Plan and Specification.

***Deliverables***

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-001: Integrated Models, Simulations and Support Plan
- DRD CEV-T-002: CEV Engineering Models
- DRD CEV-T-003: CEV CAD Models
- DRD CEV-T-004: CEV Drawings

**2.1.3 Open Architecture**

- a) The Contractor shall use a modular, multi-use open systems approach in the design of the CEV System making the impact to the overall modular, multi-use open systems architecture a primary consideration in the selection of equipment to meet the CEV design functionality. This approach shall be reflected in the architecture documented in the *Architecture Design Document (DRD CEV-T-033)*.
- b) The Contractor shall use a modular, multi-use open systems approach and analysis of long-term supportability, interoperability, and growth for future modifications in the final selection of CEV equipment and the integration approach for future Constellation elements and equipment.
- c) The Contractor's design shall permit future upgrades and incremental technology insertion to allow for incorporation of additional or higher performance components with minimal impact to the existing systems.
- d) The Contractor shall report the results of an open systems architecture analysis for modular, multi-use systems that extends beyond CEV to other Constellation elements and equipment in accordance with **DRD CEV-T-009**, *CEV Analysis Reports*.

**2.1.4 Software Engineering**

- a) The Contractor shall define, design, develop, test, qualify, integrate, verify, validate, deliver, and maintain all CEV software. The plans for accomplishing this work shall be documented in **DRD CEV-T-005**, *Software Development Plan*.
- b) The Contractor shall justify the reuse of existing software, modification of existing software, and the development of new software in **DRD CEV-T-005**, *Software Development Plan*.
- c) The Contractor shall, under CEV Project direction, participate in coordinating with the NASA IV&V Facility in accordance with NASA-STD-8739.8, NASA Software Assurance (Chapter 6 and 7) to plan for the participation of the NASA IV&V Facility in the software development lifecycle activities.
- d) The Contractor and its subcontractors' organizations associated with CEV software development responsibilities shall be at Software Engineering Institute Software Capability Maturity Model Integration (CMMI) - SE/SW/IPPD Maturity Level III (Staged Representation)

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or higher prior to the CEV Preliminary Design Review. This requirement does not apply to commercial-off-the-shelf software procured for the CEV Project.

- e) The Contractor shall develop, update, and maintain all software and software development tools under configuration management in accordance with the **DRD CEV-T-006**, *Software Configuration Management Plan*.
- f) The Contractor shall develop and maintain electronic Software Development Folders for all flight, ground, and test software per **DRD CEV-T-007**, *Software Development Folder*.
- g) The Contractor shall use the following guidance document(s) for the development of all software document deliverables:
  - o CXP-02009, Constellation Software Classification Matrix (use as guidance in interpreting flight software classification definitions in NPR 7150.2)
- h) The Contractor shall use the following standards for designing, developing, and testing all software:
  - o NPR 7150.2 NASA Software Engineering Requirements
  - o NASA-STD-8739.8, NASA Software Assurance Standard (chapters 6 and 7)

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-005: Software Development Plan
- DRD CEV-T-006: Software Configuration Management Plan
- DRD CEV-T-007: Software Development Folder

**2.1.5 System Analysis**

- a) The Contractor shall identify and conduct trade studies and cost-effectiveness analyses to ensure realistic options and alternatives are assessed for key CEV System requirements and design decisions. The assessment of cost shall address all elements of life cycle cost significantly affected by the matters being traded.
- b) The Contractor shall develop and implement a CEV System Analysis Plan. The Contractor shall deliver the analysis plan per **DRD CEV-T-008**, *CEV System Analysis Plan*. The Contractor shall include the relationship of all analysis cycles and their products to the major milestones, events, etc. they are to support in the Integrated Master Schedule as part of **DRD CEV-B-003**, *Cost Performance Report*. The Contractor shall report results of the analysis performed per **DRD CEV-T-009**, *CEV Analysis Reports*.
- c) The Contractor shall perform an integrated system performance analysis and provide reports in accordance with **DRD CEV-T-010**, *System Performance Analysis Report* at major milestone reviews and at intervals prescribed in CXP-12000, NASA CEV Project Management Plan (PM-0001).
- d) The Contractor shall provide the analysis to validate all CEV System requirements through the lowest level of decomposition and document the validation per **DRD CEV-T-009**, *CEV Analysis Reports*.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-008: CEV System Analysis Plan
- DRD CEV-T-009: CEV Analysis Reports

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- DRD CEV-T-010: System Performance Analysis Report

### 2.1.6 Integrated Logistics Support

- a) The Contractor shall develop, implement and update **DRD CEV-T-011**, *Integrated Logistics Support Plan*, using the CXP-02011, Constellation Systems Supportability Strategy as guidance.
- b) The Contractor shall perform a *Logistics Support Analysis (DRD CEV-T-012)* in accordance with the **DRD CEV-T-011**, *Integrated Logistics Support Plan*.
- c) The Contractor shall perform iterative design evaluations utilizing the results of on-going reliability, maintainability, and supportability assessments to identify logistics impacts and apply these evaluations to the design of the system in order to minimize the identified logistics impacts.
- d) The Contractor will provide initial flight spares per Section 6.5, Spacecraft Assembly, Integration, and Production; initial ground support equipment spares per Section 9.2, Ground Support Equipment; and planning for storage of spares per Section 9.4, Storage. The Contractor shall participate in the Government-sponsored Provisioning Guidance Conference and lead CEV Provisioning Conferences.
- e) The Contractor shall develop and maintain a launch site forecast of CEV propellants, fluids, and gases for the CEV Project life cycle per **DRD CEV-T-013**, *Launch Site CEV Propellants, Fluids, and Gases Forecast*.
- f) The Contractor shall provide and maintain data to support a Logistics Management System (LMS) for the tracking and management of equipment, spares, repair parts, supplies, material, and shipping containers, and identify excess or obsolete assets and initiate disposal. The LMS applies to both ground-based and space-stored assets.
- g) The Contractor shall develop the capability within the CEV spacecraft to interface/utilize the LMS for on-board inventory management.
- h) The Contractor shall deliver all supportability data developed and acquired for the design and manufacturing of CEV spacecraft to support flight hardware and Ground Support Equipment (GSE) reprourement, remanufacturing, refurbishment, failure analysis, and repair in accordance with **DRD CEV-T-014**, *Supportability Data Package*.
- i) The Contractor shall name CEV spacecraft components, assemblies, data products, applications and operations consistently in accordance with CXP-02007, Constellation Nomenclature Plan.

#### **Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-011: Integrated Logistics Support Plan
- DRD CEV-T-012: Logistics Support Analysis
- DRD CEV-T-013: Launch Site CEV Propellants, Fluids, and Gases Forecast
- DRD CEV-T-014: Supportability Data Package

### 2.1.7 Systems Test Verification and Certification

The Contractor shall develop a plan for the verification and certification of the CEV System (hardware and software) and associated subsystems and components by inspection, demonstration, analysis, and test in accordance with **DRD CEV-T-015**, *Master Verification Plan*. The plan shall satisfy the requirements of CXP-02005, Constellation Master Verification Plan.

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Certification data packages will be provided for subsystems and components that are provided by NASA for integration into the CEV System.

- a) The Contractor shall develop Certification Plans per **DRD CEV-T-016** for CEV equipment and facilities. The Contractor shall deliver Certification Data Packages per **DRD CEV-T-017** and Certification Approval Requests per **DRD CEV-T-018** in preparation for design certification milestones.
- b) The Contractor shall document the verification method for each CEV System level requirement and all lower-level requirements in a verification matrix. The matrix will be included as part of the corresponding specification, requirements, or interface document.
- c) The Contractor shall accomplish qualification of the CEV System and its hardware and software elements in accordance with CXP-02010, Constellation Environmental Qualification and Acceptance Testing Requirements (CEQATR) Document. Through rigorous testing, the Contractor shall confirm that the CEV System can deliver the planned performance over its expected service life when exposed to levels of stress with qualification margin above that defined in the predicted non-operating and operating environments and conditions. Qualification by methods other than test shall be described in the Certification Plan and be approved by the Government.
- d) The Contractor shall accomplish acceptance testing of each flight hardware item delivered in accordance with the CXP-02010, Constellation Environmental Qualification and Acceptance Testing Requirements (CEQATR) Document, including functional testing of each hardware and software operating mode at the most stressing operating conditions, environmental testing at the maximum predicted non-operating and operating environments and final functional testing.

The Contractor shall define pass-fail criteria or acceptance tolerance bands, based on requirements.

- e) The Contractor shall plan and conduct integration and interface checkout testing to assure the assembly has been completed successfully and that hardware and software functional performance meets requirements.
- f) The Contractor shall use flight-qualified software during verification testing of all subsystems and components.
- g) The Contractor shall verify software-controlled interfaces using flight-qualified software.
- h) The Contractor shall conduct systems tests of the total spacecraft with the flight-qualified hardware and software.
- i) The Contractor shall conduct tests of ground-based CEV software/hardware systems that interface with flight systems using interface test equipment that has been shown to be a valid emulation of the flight systems before connecting with the flight systems.
- j) The Contractor shall conduct tests using flight-qualified hardware and software for final acceptance of the ground-based CEV software/hardware systems used to perform launch and flight operations.
- k) The Contractor shall include the following types of tests in their program: (1) ground, (2) flight, (3) development, (4) item, (5) functional, (6) Integration, (7) Hardware-In-the-Loop (HWIL), (8) Software-In-the-Loop (SIL), (9) Human-in-the-Loop, (10) nonoperating environment, (11) operating conditions & environment, (12) acceptance, and (13) qualification. The Contractor shall document the test and verification program in the **DRD CEV-T-015, Master Verification Plan**.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-015: Master Verification Plan (MVP)

- DRD CEV-T-016: Certification Plans
- DRD CEV-T-017: Certification Data Package
- DRD CEV-T-018: Certification Approval Request

### **2.1.8 Human Engineering**

- a) The Contractor shall participate with NASA in the human engineering of the CEV System as specified in Section 6, Spacecraft and Section 9, Ground and Training Systems. Human engineering processes will be used to ensure crew and ground personnel safety, and enhance performance, efficiency, productivity, and cost effectiveness throughout the system's expected life cycle for onboard crew, ground operators, and maintainers.
- b) The Contractor shall perform all human engineering in accordance with CXP-01000, Constellation Human System Integration Requirements (HSIR) (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List).

c)

### **2.1.9 Specialty Engineering**

Specialty Engineering applies the crosscutting specialty engineering disciplines of materials and processes, electromagnetic compatibility, Electrical, Electronic, and Electromechanical (EEE) parts, and environments to the CEV System.

- a) The Contractor shall apply specialty engineering throughout the life cycle of the CEV System.
- b) The Contractor's approach to incorporating the engineering specialties into the systems engineering process and the technical effort required shall be documented in **DRD CEV-M-001, CEV Prime Project Management Plan**.

#### **2.1.9.1 Materials and Processes**

- a) The Contractor shall ensure materials are selected, controlled, implemented and verified to be consistent with their intended usage environments.
- b) The Contractor shall select, treat, fabricate, inspect, test, and analyze materials of construction to ensure the safety and success of the CEV System.
- c) The Contractor shall develop and implement **DRD CEV-T-019, Materials and Processes Selection, Implementation, and Control Plan** that tailors the requirements and applicable documents of JSC-49774A, Standard Manned Spacecraft Requirements for Materials and Processes, indicating the degree of conformance and method of implementation for each requirement as well as providing rationale for any requirements altered or not implemented.
- d) The Contractor shall develop and implement corona design criteria as guided by MSFC-STD-531, High Voltage Design Criteria and JPR 8080.5, E-6, JSC Design and Procedural Standard E-6, Corona Suppression.

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- e) The Contractor shall use the following applicable standards for Materials and Processes or demonstrate use of an equivalent standard:
- o IPC/EIA J-STD-001, Performance Class 3 with Space Addendum (Requirements for Soldered Electrical and Electronic Assemblies)
  - o IPC-A-610, Acceptability of Electronic Assemblies - Performance Class 3
  - o JPR 8080.5, E-6, JSC Design and Procedural Standard E-6, Corona Suppression
  - o JPR 8080.5, E-14, JSC Design and Procedural Standard, E-14, Electrical Wire Harness Acceptance Testing
  - o JPR 8080.5, E-24, JSC Design and Procedural Standard, E-24, Electrical Wire and Cable Acceptance Test
  - o JSC 49774A, Standard Manned Spacecraft Requirements for Materials and Processes (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-019: Materials and Processes Selection, Implementation, and Control Plan
- DRD CEV-T-020: Materials Usage Agreements (MUA)
- DRD CEV-T-021: Contamination Control Plan (CCP)
- DRD CEV-T-022: Materials Identification and Usage List (MIUL)
- DRD CEV-T-023: Nondestructive Evaluation Plan
- DRD CEV-T-024: Corona Design Criteria

**2.1.9.2 Electromagnetic Compatibility**

- a) The Contractor shall design, develop, verify and deliver a CEV System that is electromagnetically compatible with internally generated electromagnetic energy, the external electromagnetic energy environments, and the other elements of the Constellation System throughout its life cycle.
- b) The Contractor shall develop and implement **DRD CEV-T-025, CEV Electromagnetic Compatibility (EMC) Control and Verification Document** to define the plans, processes, procedures, and test data that the Contractor will use to design, construct, and verify the CEV System electromagnetic compatibility requirements.
- c) The Contractor shall tailor MIL-STD-461E, Requirements for the Control of Electromagnetic Interference (EMI) Characteristics of Subsystems and Equipment and MIL-STD-464A, Electromagnetic Environmental Effects Requirements for Systems, to assist in establishing the Contractor's documented requirements to meet the overall EMC requirements for CEV. This tailoring shall be documented in **DRD CEV-T-025, CEV Electromagnetic Compatibility Control and Verification Document**.
- d) The Contractor shall develop and design the CEV System to control and mitigate hardware malfunction and damage throughout its life cycle that can be caused by lightning. The Contractor's CEV lightning protection effort shall include the Lightning Protection Plan, the Lightning Verification Plan, and the Lightning Protection Verification Report information requested in **DRD CEV-T-025, CEV Electromagnetic Compatibility Control and Verification Document**.
- e) The CEV Contractor shall participate with NASA and the Constellation Program in development of Radio Frequency (RF) spectrum management in compliance with the National Telecommunications and Information Administration (NTIA) Manual of Regulations &

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Procedures for Federal Radio Frequency Management (May 2003 Edition, May 2005 Revisions), Chapter 10. The Contractor shall provide RF spectrum management documentation in **DRD CEV-T-026**, *Spectrum Management Documents*.

- f) The Contractor shall develop and implement an Electrostatic Discharge (ESD) control program. The Contractor's electrostatic discharge control program and processes shall be documented in **DRD CEV-T-025**, *CEV Electromagnetic Compatibility (EMC) Control and Verification Document*. The CEV System shall be constructed and delivered in accordance with these ESD processes.
- g) The Contractor shall design and deliver a CEV System which complies with the requirements of NASA-STD-4003, Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment. The Contractor's processes for implementing electrical bonding requirements shall be documented in **DRD CEV-T-025**, *CEV Electromagnetic Compatibility (EMC) Control and Verification Document*.
- h) The Contractor shall tailor ML0303-0014, Electrical Wire Harnesses and Coaxial Cables, Installation Requirements for Electromagnetic Compatibility; SSP 30240, Space Station Grounding Requirements; and SSP 30242, Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility to establish the Contractor's documented requirements to meet the overall EMC requirements for the CEV System. This tailoring shall be documented in **DRD CEV-T-025**, *CEV Electromagnetic Compatibility Control and Verification Document*. The CEV System shall be designed, constructed, and delivered in accordance with the Contractor's wire/harness/cable installation processes.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-025: CEV Electromagnetic Compatibility Control and Verification Document
- DRD CEV-T-026: Spectrum Management Documents

**2.1.9.3 Electrical, Electronic, and Electromechanical (EEE) Parts**

- a) The Contractor shall develop, update, and implement **DRD CEV-T-027**, *Electrical, Electronic, and Electromechanical Parts Management and Implementation Plan* for the CEV System.
- b) The Contractor shall use the following applicable standards for EEE Parts:
  - JPR 8080.5, E-7, JSC Design and Procedural Standards, Section E-7, Electrical Components – Restrictions on Use
  - JPR 8080.5, E-22, JSC Design and Procedural Standards, Section E-22, Ionizing Radiation Effects

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-027: Electrical, Electronic, and Electromechanical Parts Management and Implementation Plan
- DRD CEV-T-028: As-Built EEE Parts List

**2.1.9.4 Environments**

- a) The Contractor shall design the CEV System for the specific natural environments and induced environments that the CEV System must operate within and for which the CEV System must be qualified, encompassing all phases of CEV System production, testing and operation in all modes through disposal in accordance with CXP-00102, Constellation Design Specification for Natural Environments (DSNE) (and associated Children documents as



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specified in Attachment J-3, Applicable, Guidance, and Informational Documents List) utilizing the CXP-05000, Constellation Program Natural Environment Definition for Design (NEDD). The Contractor shall use the CXP-15002, Crew Exploration Vehicle (CEV)/Crew Launch Vehicle (CLV) Loads Requirements Data Book for launch vehicle induced loads.

- b) The Contractor shall derive, control and validate environment data and analysis models for the design, certification, and operation of the CEV System, subsystems, and components.

**2.1.10 Crew Survival**

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**2.2 External Integration****2.2.1 CEV to Constellation Program Integration**

- a) The Contractor shall support NASA in the performance of all work necessary to successfully integrate the CEV System into the Constellation Program. The external interfaces include:

- Crew Launch Vehicle (CLV)
- Lunar Surface Access Module (LSAM)
- Earth Departure Stage (EDS);
- Mission Planning, Training, and Flight Operations
- Ground Operations
- Communications and Tracking
- EVA

Support shall include:

- Coordination of the development, allocation, and implementation of integration requirements between the CEV System and other Constellation elements.
  - Development of the CEV to other Constellation element External Interface Control Documents per **DRD CEV-T-029**, *Interface Control Documents*
  - Design, development, test, and evaluation of the interfaces between the CEV System and other Constellation Program elements and the integrated performance of the CEV with the other Constellation Program elements for nominal, as well as critical, contingency design cases including abort design cases as appropriate. NASA will provide aerodynamic and aerothermodynamic analyses for the CEV while mated to its launch vehicle and while unmated. The Contractor shall design the CEV for the resultant induced structural and thermodynamic loads. The Contractor shall use the CXP-15002, Crew Exploration Vehicle (CEV)/Crew Launch Vehicle (CLV) Loads Requirements Data Book for loads analysis of the CEV while mated to its launch vehicle.
- b) The Contractor shall perform analyses and tests and provide reports and engineering data supporting integration and operation of CEV and other Constellation elements such as:

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- Structural models and analyses for static, dynamic and coupled-loads analyses
- Mass properties, dimensions and physical (material, thermal, etc.) properties
- Rendezvous, proximity operations, and abort mode trigger condition and implementation assessments
- Integrated compatibility analyses (EMC, RF, etc.)
- Interface and integration drawings and build/test procedures

The reports and engineering data shall be provided in **DRD CEV-T-010**, *System Performance Analysis Reports*.

- c) The Contractor shall develop, deliver, and sustain CEV System functional and physical interface simulator(s) and emulator(s) in compliance with the relevant Interface Control Document (ICD) requirements for use by other Constellation projects (including CLV and LSAM) to produce and evaluate the element interfaces to the CEV. The Contractor shall include operating instructions for the interface simulator(s) and emulator(s) in the **DRD CEV-T-040**, *Acceptance Data Package(s)* delivered with the simulators and emulators.
- d) The Contractor shall verify the CEV spacecraft with physical and functional simulators and emulators prior to integration with the other Constellation elements. The Contractor shall define requirements for Constellation element-provided physical and functional interface simulators and emulators. Physical and functional interface simulator and emulator requirements shall be delivered in accordance with **DRD CEV-T-031**, *CEV <Level> Requirements Specification* and **DRD CEV-T-029**, *Interface Control Documents* for ground support equipment.
- e) The Contractor shall perform analyses and support integrated assessments in support of periodic Constellation Program Integration Reviews conducted in conjunction with other NASA elements as described in **DRD CEV-M-001**, *CEV Prime Project Management Plan*. Analyses and assessments performed in support of Constellation Integration Reviews shall be documented in accordance with **DRD CEV-T-030**, *CEV/Constellation Integrated Assessment Document*.
- f) The Contractor shall provide/receive various mathematical models, configuration data, and analytical data necessary to perform integrated assessments and analysis to integrate with the Constellation Program in accordance with Section 2.1.2, *Integrated Models and Simulations*.
- g) The Contractor shall participate with Constellation Program SE&I in the development of integrated verification plans involving multiple systems across the Constellation Program.
- h) The Contractor shall participate in integrated verification activities involving multiple systems across the Constellation Program including necessary in-space communication systems in accordance with CXP-02005, *Constellation Master Verification Plan*.
- i) The Contractor shall participate with Constellation Operations in the development of operations plans involving multiple systems across the Constellation Program.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-029: Interface Control Documents
- DRD CEV-T-030: CEV/Constellation Integrated Assessment Document

**2.2.2 CEV to International Space Station Program Integration**

- a) The Contractor shall support NASA in the performance of all work necessary to successfully integrate the CEV System with the ISS Program. Support shall include:

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- Coordination of the development, allocation, and implementation of integration requirements between the CEV System and the ISS Program.
  - Development of the CEV to ISS External Interface Control Documents per **DRD CEV-T-029, Interface Control Documents**
  - Design, development, test, and evaluation of the interfaces between the CEV and ISS and the integrated performance of the CEV with the ISS for nominal as well as critical contingency design cases.
- b) The Contractor shall perform analyses and tests and provide reports and engineering data supporting integration and operation of CEV and ISS appropriate to such integration, such as:
- Structural models and analyses for static, dynamic and coupled loads analyses
  - Mass properties, dimensions and physical (material, thermal, etc.) properties
  - Rendezvous, proximity operations, and abort trigger condition and implementation assessments
  - Integrated compatibility analyses (EMC, RF, etc.)
  - Interface and integration drawings and build/test procedures

The reports and engineering data shall be provided in **DRD CEV-T-010, System Performance Analysis Reports**.

- c) The Contractor shall develop, deliver, and sustain functional and physical interface simulator(s) and emulator(s) in compliance with the relevant ICD requirements for use by the ISS Program to produce and evaluate ISS interfaces to the CEV. The Contractor shall include operating instructions for the interface simulator(s) and emulator(s) in the **DRD CEV-T-040, Acceptance Data Package(s)** delivered with the simulators and emulators.
- d) The Contractor shall verify the CEV spacecraft with physical and functional simulators and emulators prior to integration with the ISS. The Contractor shall define requirements for ISS-provided physical and functional interface simulators and emulators. Physical and functional interface simulator and emulator requirements shall be delivered in accordance with **DRD CEV-T-031, CEV <Level> Requirements Specification**, and **DRD CEV-T-029, Interface Control Documents** for ground support equipment.
- e) The Contractor shall provide/receive various mathematical models, configuration data, and analytical data necessary to perform integrated assessments and analysis to integrate with the ISS Program in accordance with Section 2.1.2, Integrated Models and Simulations.
- f) The Contractor shall participate in the development of integrated verification plans with the ISS Program.
- g) The Contractor shall participate in integrated verification activities with the ISS Program and in-space communication systems as required in the CXP-01007, International Space Station (ISS) to Crew Exploration Vehicle (CEV) IRD.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-029: Interface Control Documents

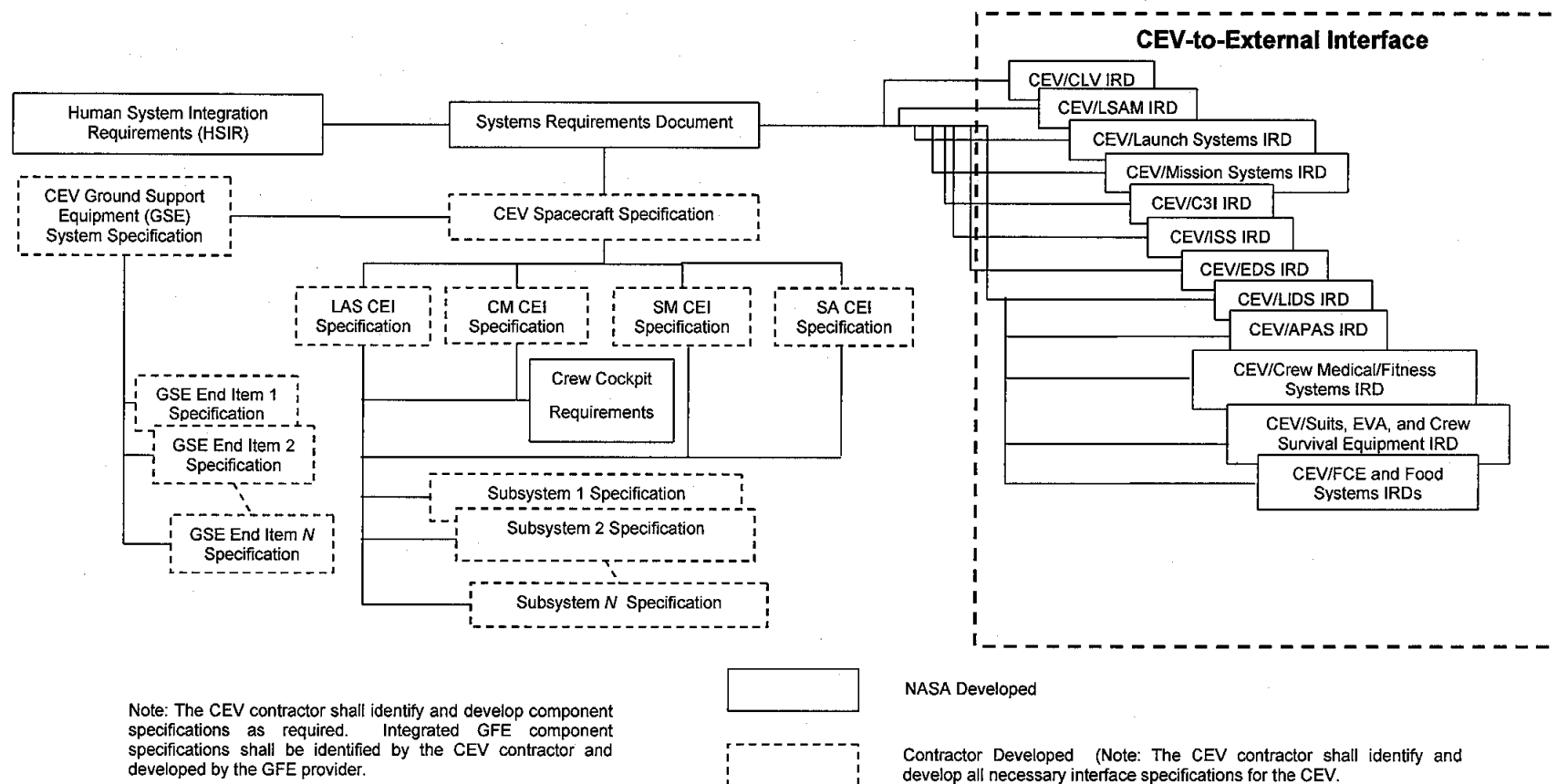
**2.3 Requirements Definition and Management**

- a) The Contractor shall address all life cycle processes including development, manufacturing, test, distribution, operation, support, training, and disposal to derive a complete requirements (functional) baseline and functional architecture.

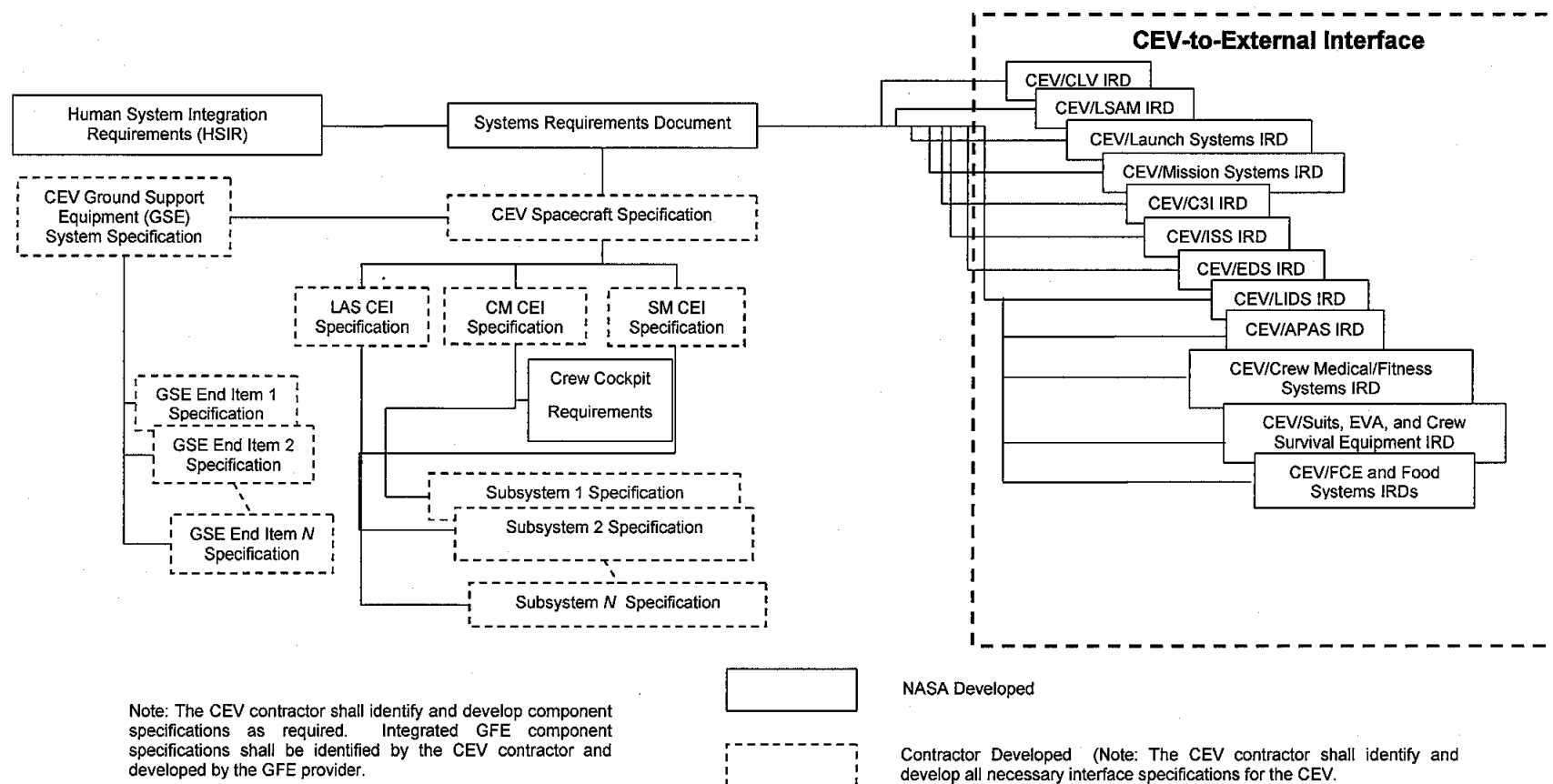
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- b) The Contractor, in conjunction with NASA, shall allocate the CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD), and External IRDs to the Spacecraft and ground support equipment as seen in Figure 1, Specification Tree. The Contractor shall document the requirements developed from this process in the Spacecraft <System> Requirements Specification and the Ground Support Equipment <System> Requirements Specification per **DRD CEV-T-031**, *CEV <Level> Requirements Specification*, and in **DRD CEV-T-032**, *CEV Specification and Drawing Trees*.

**Figure 1. – CEV Specification Tree**



**Figure 1. – CEV Specification Tree**



- c) The Contractor shall document the functional decomposition, requirements allocation, and design to the component level in **DRD CEV-T-033, *Architecture Design Document***.
- d) The Contractor shall provide a requirements database within a Systems Engineering tool to maintain bi-directional requirements traceability from the CEV System level/EIRDs and the CEV subsystem level requirements throughout the requirements allocation process to the component level. The System Engineering tool or toolset shall also include a functional model to which the requirements are linked. The Contractor shall provide NASA access to this capability through NASA ICE and provide traceability reports at all milestone reviews to verify requirements traceability. This traceability shall be maintained and continue through the design, procurement specifications, hardware and software configuration items requirements, and verification of the requirements and results. Traceability shall be documented per **DRD CEV-T-034, *Requirements Traceability Report***.
- e) The Contractor shall configuration manage the allocated requirements baseline and architecture throughout the performance period of this contract in accordance with Section 1.1.4, Configuration Management.
- f) The Contractor shall perform \_\_\_\_\_ analyses to validate the allocation of requirements and document the results in **DRD CEV-T-010, *System Performance Analysis Report***.
- g)

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### ***Deliverables***

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-031: CEV <Level> Requirements Specification
- DRD CEV-T-032: CEV Specification and Drawing Trees
- DRD CEV-T-033: Architecture Design Document
- DRD CEV-T-034: Requirements Traceability Report

### 3 SAFETY AND MISSION ASSURANCE

- a) The Contractor shall demonstrate and document compliance with requirements stated in the CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD) for safety, reliability, maintainability, supportability, manufacturability, hardware and software quality assurance, industrial safety, and environmental safety for all aspects of the CEV System.
- b) The Contractor shall develop, implement and maintain an *Safety and Mission Assurance (S&MA) Plan (DRD CEV-S-001)*, which defines their S&MA organization (within the Project and within S&MA) including subcontractors, processes, required skills, tasks and products for the CEV System.
- c) The Contractor shall incorporate and maintain in the Integrated Master Schedule S&MA flight safety reviews, ground safety reviews, forum meetings, and all DRD deliveries.
- d) The Contractor shall provide S&MA representation for CEV System technical, operations and management forums, boards/panels and project reviews.
- e) The Contractor shall provide S&MA representation for Flight Safety Review Panels and Ground Safety Review Panels.
- f) The Contractor shall provide an S&MA evaluation of flight rules, change requests, procedures, and contingency operations for both ground and flight operations.
- g) The Contractor shall provide S&MA support for the CEV System integrated project risk assessment for the Constellation Program.
- h) The Contractor shall generate, document, analyze and incorporate lessons learned for incorporation into NASA's Lessons Learned database per **DRD CEV-S-001**, *Safety and Mission Assurance (S&MA) Plan*.
- i) The Contractor shall provide an S&MA evaluation of all waivers, deviations, and changes with an emphasis on impacts to safety and mission success.

#### **Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-S-001: Safety and Mission Assurance (S&MA) Plan

### 3.1 System Safety

- a) The Contractor shall perform System Safety Hazard Analyses per **DRD CEV-S-003**, *System Safety Hazard Analyses*.
- b) The Contractor shall deliver safety data packages per **DRD CEV-S-003**, *System Safety Hazard Analyses*, (which include the Hazard Analysis, mitigations and controls, design drawings, schematics, systems descriptions and system analysis) at all phased safety reviews in accordance with the project schedule and CXP-02012, Methodology For Conduct of Project Constellation Hazard Analyses (Section 6, Hazard Reports).
- c) The Contractor shall perform fault trees analyses to identify, mitigate and control the hazards of the CEV System throughout the CEV System life cycle using FTH, Fault Tree Handbook with Aerospace Applications, August 2002, version 1.1 (Chapters 1-9), as guidance, and, shall document and deliver the results per **DRD CEV-S-002**, *Fault Tree Analysis*.
- d) The Contractor shall deliver all CEV System hazard reports, hazard analyses, and rationale to the Constellation Hazards Database.

#### **Deliverables**

The Contractor shall deliver and maintain the following document(s):



## Crew Exploration Vehicle – (CEV)

- DRD CEV-S-002: Fault Tree Analysis
- DRD CEV-S-003: System Safety Hazard Analyses

### **3.2 Industrial, Environmental, Processing Site, Launch Site and Range Safety**

- a) The Contractor shall develop and deliver a mishap prevention plan per **DRD CEV-S-004** (*Mishap Plan and Safety Statistics*).
- b) The Contractor shall provide immediate verbal notification (upon discovery) and prompt written reporting (within 24 hours) to the NASA safety office and contracting officer of any accident, incident, or exposure resulting in fatality, lost-time occupational injury, disease, contamination of property beyond any stated acceptable limits, or property loss of \$1,000 or more. In addition, the Contractor shall provide mishap, close calls, and safety statistics including trend items per **DRD CEV-S-004**, *Mishap Plan and Safety Statistics*, and shall assist the NASA investigating authority, as requested, in investigating these incidents.
- c) The Contractor shall provide information and technical data to support NASA's completion of a National Environmental Policy Act (NEPA) analysis for the CEV project in accordance with NPR 8580.1, Implementing the National Environmental Policy Act and Executive Order 12114.
- d) The Contractor shall perform a Ground Processing Safety Analysis to establish requirements for implementation into the spacecraft design and ground support equipment designs. The results shall be documented in accordance with **DRD CEV-S-005**, *CEV Ground Processing Certification Report*.
- e) The Contractor safety organization shall actively participate in Test Readiness Reviews to ensure personnel and hardware safety.
- f) The Contractor shall provide S&MA data to support a range safety flight termination system (FTS) determination analysis per NPR 8715.5, Range Safety Program, and AFSPCMAN 91-710, Range Safety User Requirements Manual in accordance with the requirements in SOW Section 7.4, Range Safety.
- g) The Contractor shall furnish a list of all hazardous operations to be performed and a list of key operations planned in the performance of the contract per **DRD CEV-S-006**, *Hazardous/Key Operations List*.
- h) The Contractor shall provide S&MA data to support the range safety analysis per **DRD CEV-S-003**, *System Safety Hazard Analysis*, and **DRD CEV-S-010**, *Probabilistic Risk Assessment Results*, to meet all local test range safety requirements.
- i) The Contractor shall coordinate with the CEV Project and the Range Safety Officer (RSO) to develop and implement operational range safety requirements, plans, procedures, and check lists including mission rules and flight commit criteria, in accordance with **DRD CEV-O-007**, *Range Safety Requirements Document*.
- j) The Contractor shall perform an orbital debris assessment on the CEV system per **DRD CEV-S-007**, *Orbital Debris Assessment*, to determine the amount of orbital debris that may be generated both in nominal and malfunction operations and for collisions in orbit.
- k) The Contractor shall provide a safety and health program which identifies, eliminates, mitigates and controls hazards and risks in all Contractor activities and document the plan in **DRD CEV-S-008**, *Safety and Health Plan*.
- l) The Contractor and their subcontractors (if any) shall follow applicable OSHA, NASA, and CEV safety and health requirements. The Contractor and their subcontractors shall document

this “flow down” of safety and health responsibility in the *Safety and Health Plan* (**DRD CEV-S-008**).

***Deliverables***

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-S-004: Mishap Plan and Safety Statistics
- DRD CEV-S-005: CEV Ground Processing Certification Report
- DRD CEV-S-006: Hazardous, Key Operations List
- DRD CEV-S-007: Orbital Debris Assessment
- DRD CEV-S-008: Safety and Health Plan

**3.3 Reliability, Maintainability, and Supportability (RMS)**

- a) The Contractor shall develop, implement, and maintain an RMS Plan per **DRD CEV-S-001**, *Safety and Mission Assurance (S&MA) Plan*, which defines the implementation of RMS within their organization including processes, required skills, tasks and products for the CEV System.
- b) The Contractor shall perform Failure Modes Effects Analyses /Critical Items Lists (FMEA/CIL) and document the results per **DRD CEV-S-009**, *Failure Mode and Effects Analysis & Critical Items List (FMEA/CIL)*.
- c) The Contractor shall perform CEV System Probabilistic Risk Assessments for identification of high-risk hardware, software and operations per **DRD CEV-S-010**, *Probabilistic Risk Assessment Results*.
- d) The Contractor shall perform Reliability, Maintainability, and Supportability analyses for the reliability and maintainability requirements for the CEV System and shall document the results per the **DRD CEV-S-011**, *Reliability, Maintainability, and Supportability Integrated Report*. These results will be used to support the maintenance concept.
- e) The Contractor shall identify where Design for Minimum Risk (DFMR) is used in lieu of fault tolerance, where adding additional redundancy is not technically feasible or where redundancy would negatively impact overall system safety and reliability. The Contractor shall identify the rationale for acceptance of these DFMR functions designs. The Contractor shall document the above in **DRD CEV-S-011**, *Reliability, Maintainability, and Supportability Integrated Report*.

***Deliverables***

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-S-009: Failure Modes Effects Analysis & Critical Items List (FMEA/CIL)
- DRD CEV-S-010: Probabilistic Risk Assessment Results
- DRD CEV-S-011: Reliability, Maintainability, and Supportability Integrated Report
- DRD CEV-S-012: Government-Industry Data Exchange Program and NASA Advisories/ALERTS

### 3.4 Hardware Quality Assurance

- a) The Contractor shall develop, implement and maintain a quality management system and Quality Assurance Plan per **DRD CEV-S-001**, *Safety and Mission Assurance (S&MA) Plan*, and in accordance with CXP-20006, Constellation Program Quality Document. The Quality Assurance Plan shall define their Quality Assurance organization including processes, required skills, tasks and products for the CEV project.
- b) The Contractor shall implement and document a Problem Reporting and Corrective Action (PRACA) system and provide all reportable problems, their status, and corrective actions, for both hardware and software per **DRD CEV-S-013**, *Problem Reporting and Corrective Action (PRACA) Reports*.
- c) The Contractor shall identify, track, and disposition all hardware and software non-conformances, anomalies, and discrepancies in a Contractor database and provide NASA with access to these records, for the life of the Project.
- d) The Contractor shall perform internal and subcontractor audits per the *Safety and Mission Assurance (S&MA) Plan (DRD CEV-S-001)*. The Contractor shall document the findings and results of the internal and subcontractor audits per **DRD CEV-S-014**, *Quality Assurance Audit Reports*.
- e) The Contractor's S&MA organization shall review design specifications and designs to determine compliance with required materials specifications.
- f) The Contractor's S&MA organization shall review Materials and Special Processes activities in the CEV Spacecraft Manufacturing process, to ensure compliance with materials and process control specifications (including welding and brazing assurance, and NDE expertise to assure proper methods, techniques and standards are being used in the performance of NDE upon the hardware).
- g) The Contractor's S&MA organization shall participate in the Fracture Control Board for the CEV System to evaluate fracture-critical hardware.
- h) The Contractor shall document the controls for those manufacturing processes where uniform high quality cannot be ensured by inspection alone per **DRD CEV-S-015**, *Critical Processes*.
- i) The Contractor shall develop, implement, and document a Mechanical Parts Assurance Plan for flight and critical ground support equipment hardware per **DRD CEV-S-016**, *Mechanical Parts Management and Implementation Plan*.
- j) The Contractor shall document its workmanship standards/specifications to ensure that they meet or exceed applicable NASA and Program Standards per **DRD CEV-S-017**, *Workmanship Standards*.

#### **Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-S-013: Problem Reporting and Corrective Action (PRACA) Reports
- DRD CEV-S-014: Quality Assurance (QA) Audit Report
- DRD CEV-S-015: Critical Processes
- DRD CEV-S-016: Mechanical Parts Management and Implementation Plan
- DRD CEV-S-017: Workmanship Standards

### **3.5 Software Assurance and Safety**

- a) The Contractor shall develop, implement, and maintain a Software Assurance Plan per **DRD CEV-S-001, Safety and Mission Assurance (S&MA) Plan, Chapter 6.**
- b) The Contractor shall demonstrate and document software assurance functions for all software in the CEV System in accordance with NASA-STD 8739.8 NASA Software Assurance Standard
  - o Chapter 6, Provider Software Assurance
  - o Chapter 7, Software Assurance Disciplines.
- c) The Contractor shall audit its own and any software suppliers internal software assurance activities to allow evaluation of both the progress and effectiveness of software assurance tasks and the need for adjustments or changes and document the results in **DRD CEV-S-018, Software Quality Assurance (SQA) Audit Reports.**
- d) The Contractor shall implement a systematic approach to software safety as an integral part of the project's overall system safety program, per **DRD CEV-S-001, Safety and Mission Assurance (S&MA) Plan, Chapter 2 - System Safety Plan.**

#### **Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-S-018: Software Quality Assurance (SQA) Audit Report

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## **6 SPACECRAFT**

- a) The Contractor shall design, develop, test, certify, and deliver CEV Spacecraft subsystem hardware complying with all requirements in CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD) (including the listed applicable documents and those included in this Statement of Work (SOW)).
- b) NASA will provide the following products to the Contractor for execution of the above effort:
  - o CXP-15000, Crew Exploration Vehicle (CEV) Crew Module Outer Mold Line (OML)
  - o CXP-15001, Crew Exploration Vehicle (CEV) Aerodynamic and Aerothermal Databases (for all phases of flight)
  - o CEV Spacecraft docking components (Androgynous Peripheral Assembly System (APAS) and Low Impact Docking System (LIDS)) of the docking system for ISS and LSAM docking requirements
  - o Parachute system in support of nominal and abort entries
  - o Pyrotechnics initiators

All Government Furnished Equipment (GFE) product teams will produce data deliverables equivalent to the contractor furnished equipment product data deliverables.

- c) The Contractor shall integrate the NASA-provided products into the spacecraft design and flight configurations to ensure that the integrated spacecraft meets CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD). The Contractor shall integrate the NASA-provided products and documentation into applicable product deliverables included in this SOW (these include requirements, drawings, certification packages, integrated analyses, and the spacecraft).
- d) NASA will maintain detailed oversight of all spacecraft design activities. The Contractor shall maintain responsibility for delivery of a design that meets the requirements. The detailed process discussion to accomplish this can be found in CXP-12000, NASA CEV Project Management Plan (PM-0001). The Contractor shall include NASA personnel on all design teams established by the Contractor.
- e) NASA will perform independent requirements validation and design certification in key areas. In these key areas NASA will establish design requirements teams intended to integrate the activities of NASA and the Contractor. The Contractor shall participate in and support these design requirements teams in GN&C Flight Software and CEV Avionics Integration Laboratory Requirements.
- f) NASA will lead, and the Contractor shall participate in, the Crew Cabin and Cockpit Layout design requirements team.
- g) NASA will lead, and the Contractor shall participate in, joint advanced development activities for the CEV landing attenuation and thermal protection systems through the Preliminary Design Review (PDR). The Contractor shall develop and implement plans, which detail the transition from development to insertion into the primary design path, for these advanced technologies. The Contractor shall document these plans in the design and data books for each subsystem.

### **6.1 Spacecraft Systems Engineering**

- a) The Contractor shall develop, maintain, and deliver all drawings and technical Computer Aided Design (CAD) models of the CEV Spacecraft system, modules, subsystems and components. The Contractor shall use **DRD CEV-T-003**, *CEV CAD Models*, and **DRD CEV-T-004**, *CEV Drawings*, as the template for development and delivery of these items.

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Additional specialized models and drawings may be specified within the spacecraft specialty engineering and spacecraft subsystem DRDs.

- b) NASA will develop drawings and CAD models for all GFE referenced in 6.0 b). NASA will use **DRD CEV-T-003**, *CEV CAD Models*, and **DRD CEV-T-004**, *CEV Drawings*, as the template for development and delivery of these items.
- c) The Contractor shall develop and maintain models and simulations for the CEV Spacecraft, modules, subsystems, and components using **DRD CEV-T-001**, *Integrated Models, Simulations and Support Plan*, and **DRD CEV-T-002**, *CEV Engineering Models*.
- d) NASA will develop models and simulations for all GFE referenced in 6.0 b). NASA will use **DRD CEV-T-001**, *Integrated Models, Simulations and Support Plan*, and **DRD CEV-T-002**, *CEV Engineering Models*, as the template for development and delivery of these items.
- e) The Contractor shall use the following standards for developing all subsystems:
  - o AIAA-S-080, AIAA Standard for Space Systems – Metallic Pressure Vessels Pressurized Structures, and Pressure Components
  - o AIAA-S-081, AIAA Standard for Space Systems – Composite Overwrapped Pressure Vessels

### 6.1.1 Requirements Definition and Management

- a) The Contractor shall define the modules, subsystems, components, and software units that make up the CEV Spacecraft.
- b) The Contractor shall allocate CEV Spacecraft requirements (see section 2.3, Requirements Definition and Management) down to the component level for the design of flight articles and maintain the allocations/specifications over the life of the contract. Software requirements documentation is handled in section 6.2.1.1, Flight Software.
- c) The Contractor shall document module-level requirements using **DRD CEV-T-031**, *CEV <Module> Requirements Specifications*. The Contractor shall produce a requirements document for each module.
- d) The Contractor shall document subsystem-level requirements using **DRD CEV-T-031**, *CEV <Subsystem> Requirements Specifications*. The Contractor shall produce a requirements document for each subsystem.
- e) The Contractor shall document component-level requirements using **DRD CEV-T-031**, *CEV <Component> Requirements Specifications*. The Contractor shall produce a requirements document for each component. The Contractor shall configuration manage component-level requirement specifications via a Contractor-led control board, which contains NASA membership.
- f) The Contractor shall document all hardware interfaces requirements using **DRD CEV-T-035**, *Internal Interface Requirement Document (IRD)*. The Contractor shall produce an IRD for each module that interfaces with another module. The Contractor shall produce an IRD for each subsystem that interfaces with another subsystem.
- g) The Contractor shall allocate requirements to the following government furnished products:
  - o CEV Spacecraft docking components (APAS and LIDS) of the docking system for ISS and LSAM docking requirements
  - o Parachute system in support of nominal and abort entries
  - o Pyrotechnics initiators
- h) The Contractor shall ensure that traceability between the levels is in accordance with the capability established in Section 2.3, Requirements Definition and Management.



**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-035: Internal Interface Requirements Document (IRD)

**6.1.2 Spacecraft Integration**

- a) The Contractor shall perform the system integration effort required to manage and control the internal spacecraft interface definition process.
- b) The Contractor shall manage crosscutting engineering issues within the spacecraft, such as the allocation of resources into the design elements including the management of margins and design and operational performance estimates for various subsystems. This information shall be documented in **DRD CEV-T-036**, *Margins Management Plan/Report*, and implemented by the Contractor.
- c) The Contractor shall perform analyses required to validate the allocation of requirements and shall document the results in **DRD CEV-T-010**, *System Performance Analysis Report*.
- d) The Contractor shall document all internal interface design details using **DRD CEV-T-029**, *CEV Interface Control Documents*. The Contractor shall produce an ICD for each module interfacing with another module. The Contractor shall produce an ICD for each subsystem interfacing with another subsystem.
- e) The Contractor shall document ICD(s) for the government furnished products below:
  - CEV Spacecraft docking components (APAS and LIDS) of the docking system for ISS and LSAM docking requirements
  - Parachute system in support of nominal and abort entries
  - Pyrotechnics initiators
- f) The Contractor shall design and develop the spacecraft in compliance with the NASA-provided and maintained CXP-15000, Crew Exploration Vehicle (CEV) Crew Module Outer Mold Line (OML) and Center of Gravity (Cg) box definition. The Contractor shall submit changes to NASA against the Crew Module OML baseline to accommodate maturing design features.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-036: Margins Management Plan/Report

**6.1.3 Spacecraft Crew Cabin and Cockpit Layout Design Requirements**

- a) NASA will lead, and the Contractor shall participate in, the development of detailed design requirements for the CEV crew cabin and cockpit layout. NASA will document these requirements in CXP-10002, CEV Crew Cabin/Cockpit Layout Design Requirements and Standard, which will be baselined at PDR.
- b) The Contractor shall allocate the design requirements for the CEV crew cabin and cockpit layout to the specific subsystems for implementation.
- c) The Contractor shall evaluate NASA-provided internal CEV crew cabin configurations and layouts for compatibility with the integrated spacecraft design. The Contractor shall provide inputs to NASA on design issues requiring resolution to meet integrated spacecraft requirements through PDR.

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- d) The Contractor shall provide materials (e.g., layout schematics, computer 3-D models) for two Crew Station Reviews. The Contractor shall conduct these two Crew Station Reviews between System PDR and System CDR of the Contractor's CEV crew cabin internal layout design utilizing NASA-identified Crew Office representatives. After each Crew Station Review, the Contractor shall prepare and provide to the Crew Cabin and Cockpit Layout Design team an impact assessment of quantifiable design issues arising from each review.
- e) NASA will document the detailed display format software requirements resulting from the prototyping effort in CXP-15003, CEV Display Format Standards, and deliver this document by PDR.
- f) The Contractor shall develop and maintain the Display Software Requirements Specification (**DRD CEV-T-048**), using CXP-15003, CEV Display Format Standards as an applicable document. The Contractor shall baseline the Display Software Requirements Specification (**DRD CEV-T-048**) by CDR.

#### 6.1.4 Spacecraft Test, Verification and Certification

- a) The Contractor shall develop and execute a Spacecraft Master Verification Plan for the verification, qualification, certification, and acceptance of the CEV Spacecraft system, modules, subsystems, and components. The Contractor shall use **DRD CEV-T-015, Master Verification Plan**, to develop the Spacecraft Master Verification Plan. The Contractor may use multiple volumes in the development of the Spacecraft Master Verification Plan to document the module, subsystem, and component level verification plans.
  - b) The Contractor shall perform qualification tests using **DRD CEV-T-037, Qualification Test Procedures**, and document the test results in **DRD CEV-T-038, Qualification Test Report**, and **DRD CEV-T-017, Certification Data Package**. The Contractor shall perform qualification testing at component, Spacecraft system, and intermediate levels of assembly to accumulate the data necessary for CEV Spacecraft certification. The Contractor shall produce a Certification Data Package for the spacecraft. The Contractor shall produce a Certification Data Package for each module. The Contractor shall produce a Certification Data Package for each subsystem. The Contractor shall produce a Certification Data Package for each component. Note: Software test documentation is handled in section 6.2.1.1, Flight Software.
- 
- c) The Contractor shall perform acceptance testing at the spacecraft, module, and component level using **DRD CEV-T-039, Acceptance Test Procedures**, and document the results using **DRD CEV-T-040, Acceptance Data Package**. An Acceptance Data Package shall be produced for the spacecraft. An Acceptance Data Package shall be produced for each module. An Acceptance Data Package shall be produced for each component.
  - d) The Contractor shall hold Test Readiness Reviews (TRRs) before all formal verification activities. The Contractor shall make subsystem, module, and spacecraft-level test procedures available to NASA two weeks prior to each TRR. The Contractor shall invite NASA to witness all formal verification activities, including TRRs and test executions.
  - e) The Contractor shall conduct verification testing of all interface designs and requirements within the spacecraft (between modules, between subsystems, and between components).
  - f) If the Contractor utilizes modeling and simulation to conduct analysis in support of verification specification compliance, the Contractor shall comply with **DRD CEV-T-001, Integrated Models, Simulations and Support Plan**, and **DRD CEV-T-002, CEV Engineering Models**.

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- g) The Contractor shall provide the integration, test, & verification facilities required to test and certify all spacecraft modules, subsystems, and components. The Contractor shall invite NASA to witness all subsystem facility design reviews and certification activities.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-037: Qualification Test Procedures
- DRD CEV-T-038: Qualification Test Report
- DRD CEV-T-039: Acceptance Test Procedures
- DRD CEV-T-040: Acceptance Data Package

**6.1.5 Spacecraft Specialty Engineering**

- a) The Contractor shall apply spacecraft specialty engineering in the CEV Spacecraft design.

**6.1.5.1 Aerosciences**

- a) NASA will develop, update, and implement aerothermal and aerodynamic databases as part of the design and development of the CEV Spacecraft. NASA will maintain the CEV aerothermal and aerodynamic databases for the duration of contract performance.
- b) NASA will define the initial Crew Module OML shape, including any flight control surfaces that might be required.
- c) NASA will control all changes to the configuration of the Crew Module OML shape through a NASA-led Crew Module OML Panel.
- d) NASA will document the development of the CEV databases with an explanation of the methodologies used to develop, populate, validate, and utilize the databases, including the following:
- Documentation of experimental testing, including descriptions of the model, instrumentation, facilities, test conditions, and results.
  - Computational tool documentation describing the application of Computational Fluid Dynamics (CFD) codes and engineering tools used to populate the databases including code descriptions, gas dynamic modeling assumptions, best practices followed in grid refinement and result validation.
  - Electronic files detailing solid model geometries, computational grids, and flowfield solutions used in creating the databases with complete descriptions of file formats and content.
  - Assumptions and extrapolations used to incorporate experimental and computational data into the database.
  - Specification of aerodynamic and heating uncertainties and corresponding justification.
  - Definition of constants, variables, functions, and engineering units.
  - Documentation of aerodynamic and aerothermodynamic verification analysis.
- e) The Contractor shall be responsible for using the aerothermal and aerodynamic databases for implementing the spacecraft design.
- f) The Contractor shall participate in an aerodynamic technical panel, which will coordinate the development, implementation, maintenance, and delivery of the aerodynamic database.

- g) The Contractor shall participate in an aerothermodynamic technical panel, which will coordinate the development, implementation, maintenance, and delivery of the aerothermodynamic database.
- h) The Contractor shall participate in the Crew Module OML Panel.
- i) The Contractor shall be responsible for developing all CAD models of the OML, subsequent to delivery of the initial NASA-defined OML.

#### **6.1.5.2 Instrumentation**

- a) The Contractor shall define and implement an integrated plan for CEV Spacecraft instrumentation. The Contractor shall provide in this plan provisions for the calibration of the instrumentation transducers and sensors to assure end-to-end error and tolerances are within required performance specifications. The Contractor shall document these plans in **DRD CEV-T-041, CEV Instrumentation Plan**.
- b) The Contractor shall define and document sensor range and calibration information in **DRD CEV-T-046, CEV Data and Command Dictionary**.

#### **Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-041: CEV Instrumentation Plan

#### **6.1.5.3 Mass Properties**

- a) The Contractor shall define a plan for managing mass properties and document this plan in **DRD CEV-T-042, Mass Properties Control Plan**. The Contractor shall implement this plan and document the results in **DRD CEV-T-043, Mass Properties Reports**.

#### **Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-042: Mass Properties Control Plan
- DRD CEV-T-043: Mass Properties Reports

#### **6.1.5.4 Micrometeoroid and Orbital Debris (MMOD) Analyses**

- a) The Contractor shall assess MMOD risk for loss of vehicle/crew and loss of mission based on the design MMOD environments derived from CXP-00102, Constellation Design Specification for Natural Environments (DSNE) (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List), utilizing CXP-05000, Constellation Program Natural Environment Definition for Design (NEDD).
- b) In performing the analysis and providing the protection hardware, the Contractor shall comply with the following standards:
  - NASA TP-2003-210788, Meteoroid/Debris Shielding, 2003, Section 2 for describing the MMOD risk assessment process using Bumper code
  - JPR 8080.5 M/S-11, JSC Design and Procedural Standards, Section M/S-11, Meteoroid and Orbital Debris Protection Levels for Structures

#### **Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-044: CEV MMOD Analysis Report

#### **6.1.5.5 Radiation**

- a) The Contractor shall use radiation analyses, including crew radiation exposure analysis (using analytical tools integrated to structural models), to certify that the spacecraft meets the CEV radiation requirements for the space radiation environments described in CXP-00102, Constellation Design Specification for Natural Environments (DSNE) (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List), utilizing the CXP-05000, Constellation Program Natural Environment Definition for Design (NEDD). The Contractor shall document the certification results in **DRD CEV-T-045, CEV Space Radiation Analysis and Certification Report**.
- b) The Contractor shall use the following radiation protection requirements and applicable document(s) in the design of the CEV Spacecraft:
  - o CXP-01000, Constellation Human System Integration Requirements (HSIR), Section 3.7
  - o OSHA Standards 29 CFR, Supplementary Standards 1960.18
  - o National Council on Radiation Protection and Measurements Report No. 132: Radiation Protection Guidance for Activities in Low-Earth Orbit
  - o National Council on Radiation Protection and Measurements Report No TBD: "Radiation Protection and Science Goals for Lunar Missions"; to be published in 2006 (Note: Upon completion, this document will replace National Council on Radiation Protection and Measurements Report No. 132: Radiation Protection Guidance for Activities in Low-Earth Orbit.)

#### **Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-045: CEV Space Radiation Analysis and Certification Report

## **6.2 Spacecraft Subsystems**

- a) The Contractor shall perform requirements development, design, analysis and trade studies, assembly/production, integration, testing, verification, validation, qualification, certification, and delivery for all CEV Spacecraft subsystems to the component level. A small number of subsystems contain government furnished products. These NASA-provided products will be detailed in each subsystem section.
- b) In support of the spacecraft avionics development effort, the Contractor shall provide the following for each subsystem:
  - o Validation of the subsystem's software requirements
  - o Validation of subsystem models/simulations used for flight software and integrated avionics verification
- c) The Contractor shall provide system and module-level design definition data in the **DRD CEV-T-033, Architectural Design Document** (SOW section 2.3, Requirements Definition and Management) and design definition and data down to the component level in the Subsystem Design and Data Books listed in sections 6.2.1, Avionics, through 6.2.14, Launch Abort System.
- d) The Contractor shall hold subsystem PDRs and CDRs prior to the system PDR and CDR.
- e) The Contractor shall perform analyses, trade studies, and developmental testing to determine the spacecraft architecture and component design that meets all requirements and best balances performance, cost, schedule, and risk. The Contractor shall document this design information in each of the subsystem design and data books.

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- f) The Contractor shall demonstrate how the design maps to and complies with the CEV System-level and external interface requirements. The Contractor shall document this requirements mapping in **DRD CEV-T-034**, *Requirements Traceability Report*.
- g) The Contractor shall document their approach for developing and delivering integration test assemblies and flight test articles in the *Master Verification Plan (DRD CEV-T-015)*. The Contractor shall document this information at the CEV Spacecraft system, module, subsystem, and component levels in the Spacecraft Master Verification Plan.
- h) The Contractor shall specify, produce and deliver integration testing assemblies and flight test articles necessary to implement the Spacecraft Master Verification Plan. The Contractor shall document this information at the CEV Spacecraft system, module, subsystem, and component levels in **DRD CEV-T-017**, *Certification Data Package*. Note: Subsystem and component-level test and test documentation requirements are defined in section 6.1.4, Spacecraft Test, Verification, and Certification.
- i) NASA has identified subsystem-specific standards the Contractor shall follow during all design, development, and test activities. The standards are listed in sections 6.2.1, Avionics, through 6.2.14, Launch Abort System. Crosscutting standards applying to all subsystems are covered in section 2.1.9, Specialty Engineering, and section 6.1.5, Spacecraft Specialty Engineering.
- j) The Contractor shall use the following standards and requirements documents for developing all subsystems:
  - o JPR 8080.5, JSC Design and Procedural Standards (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List) (exclusive of government "shalls")
  - o CXP-01000, Constellation Human System Integration Requirements (HSIR) (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)

**6.2.1 Avionics**

- a) The Contractor shall develop, implement, and maintain an Integrated Avionics Master Verification Plan, per **DRD CEV-T-015**, that details the Contractor's plan for verifying, certifying, and acceptance of the avionics system.
- b) The Contractor shall perform certification testing of the avionics subsystem and document the results using **DRD CEV-T-017**, *Certification Data Package*.
- c) The Contractor shall develop and maintain a sortable *CEV Data and Command Dictionary (DRD CEV-T-046)*, which includes channelization information, calibration information, telemetry information, and command information required to define, manage and record all data elements that interface with the core avionics software and hardware, the subsystem specific software, and the ground systems.
- d) The Contractor shall develop an Avionics Subsystem - Constellation C3I Interoperability Report per **DRD CEV-T-047**, *Avionics Design and Data Book Volume V - Avionics Subsystem - Constellation C3I Interoperability Report*, to detail how the Contractor's design will adhere to CXP-00101, Constellation Command, Control, Communication, and Information (C3I) Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List).
- e) The Contractor shall develop **DRD CEV-T-047**, *Avionics Design and Data Book Volume I - Avionics System-Level Data*, which contains avionics architecture diagrams, results of trade studies and performance analyses, block diagrams, schematics, prototyping results, design data, planned growth provisions/margins/scarring, and discussion of fault tolerance and effects of failures on performance.

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- f) In concert with section 2.1.3, Open Architecture, the Contractor shall utilize open architecture designs and industry standards where feasible and cost-effective in the avionics subsystem hardware and software designs, taking into consideration long-term maintainability/availability and extensibility. The Contractor shall utilize modular hardware and common building blocks such as power supplies, chassis, processor cards, memory cards, network cards, etc. where feasible and cost-effective.
- g) In concert with section 2.1.3, Open Architecture, the Contractor shall utilize standard compilers, operating systems, and software development tools/environments throughout the CEV software design and development process where feasible and cost-effective.
- h) The Contractor shall perform 400 hours burn-in testing on each avionics Line Replaceable Unit (LRU) to screen out early hardware failures.
- i) For each avionics LRU that requires active cooling, the Contractor shall perform testing to determine the maximum time that the LRU can be operated without active cooling applied. The Contractor shall document this data in each volume of the avionic design and data book.
- j) The Contractor shall use the following standards for designing the avionics subsystem:
  - o CXP-00101, Constellation Command, Control, Communication, and Information (C3I) Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)
- k)
- l)

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-046: CEV Data and Command Dictionary
- DRD CEV-T-047: Avionics Design and Data Book

**6.2.1.1 Flight Software**

- a) The Contractor shall design, develop, produce, integrate, verify, validate, certify, operate, maintain, document, and deliver CEV flight and accompanying ground and test software in accordance with all Block 1A and Block 1B requirements and in this SOW.
- b) The Contractor shall develop all flight software following the plans, processes, and standards outlined in **DRD CEV-T-005**, *Software Development Plan*, and section 2.1.4, Software Engineering.
- c) The Contractor shall allocate CEV Spacecraft requirements (section 2.3, Requirements Definition and Management) to the Computer Software Configuration Item (CSCI) level for the design of flight software and flight test software and maintain the allocations/requirements over the life of the system as development transitions to production (Schedule B) and sustaining engineering (Schedule C). The Contractor shall produce a Software Requirements Specification (SRS) for each CSCI, using **DRD CEV-T-048**, *Software Requirements Specification*.

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- d) The Contractor shall allocate the requirements of each CSCI to the Computer Software Components (CSCs) and Computer Software Units (CSUs) levels. This design breakdown shall be documented in the *Interface Control Documents (DRD CEV-T-029)* and *Software Design Description (DRD CEV-T-050)* documents.
- e) The Contractor shall plan, execute and document trade studies to identify criteria and provide resolution data for flight software issues related to the selection of software, software tools, and hardware/software architectures (e.g., operating system selections and bus architectures). The Contractor shall determine the ability of the CEV system to be upgradeable to the Block 2 configuration and perform trade studies to determine that memory, throughput, and processing margins are adequate to meet the Block 2 configuration requirements. Trade study reports shall be documented per the requirements captured in **DRD CEV-T-009**, *CEV Analysis Reports*.
- f) The Contractor shall perform unit testing of the flight software. Unit test procedures (CSU-level), CSU-to-CSU interface, CSC-level, and CSC-to-CSC interface tests will not be a deliverable to NASA; however, they shall be made available to NASA upon request via **DRD CEV-T-007**, *Software Development Folders*. All CSCI-level test procedures shall be documented in **DRD CEV-T-053**, *Software Test Description*. The Contractor shall develop and deliver **DRD CEV-T-017**, *Certification Data Package* for each CSCI and for the integrated flight software. The Contractor shall develop and deliver **DRD CEV-T-040**, *Acceptance Data Package* for each flight software deliverable.
- g) The Contractor shall perform configuration management of the flight software within their configuration management system and provide "mirror imaging" of all software development folders, source code, and documentation into ICE on a weekly basis.
- h) The Contractor shall develop a flight software mission reconfiguration process that details the Contractor's plan for flight-to-flight reconfiguration of the flight software and ground facility software to meet mission-specific requirements. The Contractor's process shall address the changing of software parameters to account for vehicle modifications, vehicle differences, or to specify values for mission-specific requirements. The Contractor shall document the reconfiguration process plans, requirements, and design in **DRD CEV-T-005**, *Software Development Plan*, **DRD CEV-T-048**, *Software Requirements Specification*, and **DRD CEV-T-050**, *Software Design Description*. The Contractor shall develop tools to support the reconfiguration process.
- i)
- j)

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-048: Software Requirements Specification
- DRD CEV-T-049: Monthly Software Metrics Report
- DRD CEV-T-050: Software Design Description
- DRD CEV-T-051: Software Inspection and Peer Review Report
- DRD CEV-T-052: Software Test Plan



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- DRD CEV-T-053: Software Test Description
- DRD CEV-T-054: Software Test Report
- DRD CEV-T-055: Software Maintenance Plan
- DRD CEV-T-056: Software User Manual
- DRD CEV-T-057: Software Version Description Document

**6.2.1.2 Command & Data Handling (C&DH)**

- a) The Contractor shall document the design for all C&DH hardware as specified in **DRD CEV-T-047, Avionics Design and Data Book Volume II - C&DH/Instrumentation Subsystem Data**.

**6.2.1.3 Communications and Tracking (C&T)**

- a) The Contractor shall prepare, deliver, and maintain **DRD CEV-T-047, Avionics Design and Data Book Volume III - Communications and Tracking Subsystem Data**.
- b) The Contractor shall participate in the development of Constellation's integrated communications and tracking concepts, architecture, and requirements. The Contractor shall comply with the design of the Constellation communications architecture according to CXP-00101, Constellation Command, Control, Communication, and Information (C3I) Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List).
- c) Subsystems other than C&T may contain RF/optical devices (i.e., wireless sensors, GPS). The Contractor shall apply the standards in this section to those subsystems containing RF/optical devices. The Contractor shall provide the same documentation required in **DRD CEV-T-047, Avionics Design and Data Book Volume III - Communications and Tracking Subsystem Data**, for all subsystems containing RF/optical devices. The Contractor shall document this information in that subsystems design and data book.
- d) The Contractor shall participate in the development of Radio Frequency/Optical ICDs and document the results in **DRD CEV-T-058, Radio Frequency/Optical ICDs**.
- e) The Contractor shall use the following standards for designing the C&T subsystem:
- 450-SNUG, Space Network Users' Guide
  - FIPS 140-2, Security Requirements for Cryptographic Module
  - FIPS-197, Advanced Encryption Standard
  - ICD-GPS-200 , Navstar GPS Space Segment/Navigation User Interfaces
  - NTIA Manual, National Telecommunications and Information Administration (NTIA) Manual of Regulations & Procedures for Federal Radio Frequency Management (May 2003 Edition, May 2005 Revisions) Chapter 10
  - IEEE 802.16e, IEEE Standard for Local and Metropolitan Area Networks, Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems - Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-058: Radio Frequency/Optical ICDs

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**6.2.1.4 Displays & Controls**

- a) The Contractor shall perform requirements development for the D&C subsystem as part of the Contractor/NASA Spacecraft Crew Cabin and Cockpit Layout Design Requirements Team described in Section 6.1.3, Spacecraft Crew Cabin and Cockpit Layout Design Requirements. This team will produce TBD-036, CEV Crew Cabin/Cockpit Layout Design Requirements and Standard.
- b) The D&C subsystem shall utilize naming conventions as established in CXP-02007, Constellation Nomenclature Plan.
- c) The Contractor shall prepare, maintain, and deliver *Avionics Design and Data Book Volume IV - Displays and Controls Subsystem Data* per **DRD CEV-T-047**.

**6.2.2 Electrical Power Subsystem**

- a) The Contractor shall participate with the Constellation Program in the development of **DRD CEV-T-060**, *Electrical Power Quality Specification Requirements Document*. The Contractor shall perform testing and analyses required to develop a power quality specification that will be compatible with the technology needed to generate, store, and distribute electrical power. The Constellation Program will provide oversight and guidance with an emphasis to tailor this specification to be compatible to both the CEV and other similar Constellation EPS systems.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-059: Electrical Power System (EPS) Design and Data Book
- DRD CEV-T-060: Electrical Power Quality Specification Requirements Document

**6.2.3 Mechanisms**

- a) For the CEV Block 1 A and 1B configurations NASA will provide the Androgynous Peripheral Assembly System (APAS) and associated data products.
- b) For the CEV Block 1 A and 1B configurations the Contractor shall integrate APAS into the CEV Spacecraft design.
- c) For the CEV Block 2 configuration NASA will provide the Low Impact Docking System (LIDS) and associated data products.
- d) For the CEV Block 2 configuration the Contractor shall integrate LIDS into the CEV Spacecraft design.
- e) The Contractor shall design and develop safety or mission critical mechanisms in accordance with the following standard:
  - NASA-STD-5017, Design and Development Requirements for Mechanisms, Sections 1-4

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-061: Mechanical Systems Design and Data Book
- DRD CEV-T-062: Stress Analysis Report

#### **6.2.4 Passive Thermal Control**

- a) The Contractor shall develop thermal analytical models to support integrated Constellation vehicle analyses and CEV thermal analyses.

##### ***Deliverables***

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-063: Passive Thermal Control Design and Data Book (PTCDDDB)
- DRD CEV-T-064: Passive Thermal Control Mathematical Models and Documentation

#### **6.2.5 Thermal Protection System**

- a) NASA will perform advanced development of two designs for the TPS forebody heat shield component, leading to the TPS subsystem PDR. The forebody heat shield component includes both the TPS materials or material system, the underlying support structure to which the TPS material is mounted, and the attachment or bonding agents or system. These two advanced development design options are as follows:
- Lunar Return capable
  - Low Earth Orbit Return capable
- b) NASA will produce the following subsystem PDR products:
- TPS Component (Forebody Heatshield) Requirements Specification (**DRD CEV-T-031**)
  - TPS Component (Forebody Heatshield) section of the *Thermal Protection System Design and Data Book (TPSDDDB)* (**DRD CEV-T-065**)
  - TPS Component (Forebody Heatshield) Math Models as part of *Thermal Protection System Mathematical Models and Documentation* (**DRD CEV-T-066**) and CEV CAD Models (**DRD CEV-T-003**)
  - Inputs to integrated Contractor products
- c) The Contractor shall participate in advanced development activities to the extent necessary to execute the efforts described in this SOW.
- d) The Contractor shall produce all remaining subsystem PDR products not produced by NASA.
- e) Following the TPS subsystem PDR, the Contractor shall perform detailed design, test, and analysis of both TPS heat shield designs.
- f) The Contractor shall develop one engineering development unit (EDU) for each heat shield design for use in Contractor and NASA testing.
- g) The Contractor shall establish a milestone for selecting one of the two TPS heat shield designs based on test and evaluation of the two designs after subsystem PDR. The Contractor shall recommend the TPS heat shield design to be used for final implementation at this milestone. The Contractor shall document this milestone in the Integrated Master Plan (IMP). NASA will select the final TPS heat shield design.
- h) The Contractor shall complete design, development, test, certification, and delivery of the selected TPS heat shield and all post-PDR DRD products.
- i) The Contractor shall design, develop, test, certify, and deliver all other CEV Spacecraft TPS components and DRD products.
- j) The Contractor shall develop thermal analytical models to support integrated Constellation vehicle analyses and CEV thermal analyses.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-065: Thermal Protection System Design and Data Book (TPSDDDB)
- DRD CEV-T-066: Thermal Protection System Mathematical Models and Documentation

**6.2.6 Structures**

- a) The Contractor shall perform structural analysis on all spacecraft structures, including pressure vessels, to show that all elements of the design such as the strength, stiffness, structural stability, and life meet all specified criteria for the anticipated loads and environments.
- b) The Contractor shall perform loads and dynamics analyses and document the results in **DRD CEV-T-067**, *Structural Loads Data Book*.
- c) The Contractor shall perform stress and fatigue analyses and document the results in **DRD CEV-T-062**, *Stress Analysis Report*.
- d) The Contractor shall develop models to support integrated Constellation vehicle analyses as well as CEV loads and stress analyses. The Contractor shall deliver **DRD CEV-T-068**, *Structures Mathematical Models and Documentation*, which will deliver and describe the mathematical models used in the CEV Spacecraft system, module, subsystem, and component loads and stress analyses.
- e) The Contractor shall implement a fracture control program and identify fracture critical parts to protect against catastrophic structural hazards associated with flaw presence, fatigue crack propagation and fracture. The Contractor shall deliver and implement **DRD CEV-T-069**, *Fracture Control Plan*, and **DRD CEV-T-070**, *Fracture Control Summary Report*.
- f) The Contractor shall use NASA-HDBK-7005, Dynamic Environmental Criteria, as a guidance document to support the **DRD CEV-T-015**, *Master Verification Plan* DRD product development activity.
- g) The Contractor shall use the following standards for designing and analyzing the structures subsystem:
  - CXP-15002, Crew Exploration Vehicle (CEV)/Crew Launch Vehicle (CLV) Loads Requirements Data Book
  - JSC-62550, Structural Design and Verification Criteria for Glass, Ceramics and Windows in Human Space Flight Applications
  - NASA-STD-5001, Structural Design and Test Factors of Safety for Space Flight Hardware
  - NASA-STD-5002, Loads Analyses of Spacecraft and Payloads
  - NASA-STD-5007, General Fracture Control Requirements for Manned Spaceflight Systems
  - NSTS 08307, Space Shuttle Criteria for Preloaded Bolts
- h)

***Deliverables***

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-067: Structural Loads Data Book
- DRD CEV-T-068: Structures Mathematical Models and Documentation
- DRD CEV-T-069: Fracture Control Plan
- DRD CEV-T-070: Fracture Control Summary Report

**6.2.7      *Propulsion***

- a) The Contractor shall perform design, development, test, certification and delivery of all propulsion systems and develop all propulsion related DRD products.
- b) The Contractor shall develop, document, implement, and execute comprehensive verification activities and associated processes for all propulsion systems in order to certify the propulsion systems for compliance with CEV component, subsystem, module, Spacecraft system, and vehicle-level requirements. The Contractor shall also design, fabricate and test integrated propulsion systems in order to evaluate and certify integrated propulsion system hot fire performance for each propulsion application. The Contractor shall also design, fabricate, and test integrated propulsion systems to evaluate and certify integrated propellant system storage and conditioning designs and capabilities in order to evaluate and certify propellant conditioning performances. The Contractor shall design and certify liquid propellant rocket engines for combustion stability, using CPIA 655, Guidelines for Combustion Stability Specifications and Verification Procedures for Liquid Propellant Rocket Engines, as a guidance document in this design and certification effort.

c)

***Deliverables***

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-071: Propulsion Systems Design and Data Book

**6.2.8      *Suits, EVA and Survival Crew Equipment Support Systems***

- a) NASA will provide the CEV suits and EVA support equipment (e.g., EVA suits, launch and entry suits, helmets, gloves, undergarments, and standard EVA tools if applicable).
- b) NASA will provide crew equipment systems and gear for emergency egress and survival, crew/personnel post landing tracking systems, and crew/personnel postlanding communications systems.
- c) The Contractor shall perform requirements development, design, analysis and trade studies, assembly/production, integration, testing, verification, validation, qualification, certification, and delivery of the CEV interfaces for the NASA-provided suits, EVA support equipment, and survival crew equipment.
- d) The Contractor shall supply the raw vehicle resources to supply the NASA-provided suits with power, oxygen, water, cooling, contaminant control and communications as defined in the CXP-01009, Suits, EVA and Survival Crew Equipment to CEV IRD. The Contractor shall control/provide/analyze the vehicle side interface, and NASA will control/provide the umbilical/support systems hardware and the suit-side interface.
- e) The Contractor shall supply vehicle resources and interfaces for vehicle depressurization/re-pressurization as defined in support of an EVA.

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- f) The Contractor shall provide an IVA/EVA-operable CEV Spacecraft hatch and mechanisms, specialized CEV-specific EVA tools, and external devices, restraints, and mobility aids.
- g) The Contractor shall use the human engineering standards listed in section 2.1.8, Human Engineering, to design all interfaces to suits, EVA, and survival crew equipment systems.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-072: Suits, EVA and Survival Crew Equipment Support Systems Design and Data Book

### **6.2.9 Environmental Control and Life Support (ECLS), Crew Health and Habitation Accommodations**

- a) NASA will provide food and food packaging. The Contractor shall design the interfaces for these NASA-provided items.
- b) NASA will provide portable medical kits, equipment, and supplies, and portable countermeasures systems. The Contractor shall design the interfaces for these NASA-provided items.
- c) NASA will provide additional FCE such as personal hygiene kits, hygiene consumables, sleep restraints, portable supplemental lighting, portable vacuum cleaner, dust abatement system, disposable wipes, personal carry-on stowage, standard tools, crew clothing, and portable crew personal items (e.g., relaxation and entertainment systems). The Contractor shall design the interfaces for these NASA-provided items.
- d) The Contractor shall use the following ECLS, crew health and habitation accommodations standards and the Human Engineering Standards listed in section 2.1.8, Human Engineering, for designing this subsystem:
  - JSC 20584, Spacecraft Maximum Allowable Concentrations for Airborne Contaminants
- e) The Contractor shall provide definition of the process to be used for cleanliness of components for use in oxygen, fuel, and pneumatic systems. The Contractor shall provide this information in **DRD CEV-T-073, Environmental Control and Life Support Design and Data Book**. The process must meet or exceed the requirements identified in the following documents:
  - MSFC-SPEC-164B, Specification for Cleanliness of Components for Use in Oxygen, Fuel and Pneumatic Systems (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)
  - MSFC-PROC-404, Gases, Drying and Preservation, Cleanliness Level and Inspection
  - MSFC-PROC-1831, The Analysis of Nonvolatile Residue Content
  - MSFC-PROC-1832, Sampling and Analysis of Nonvolatile Residue Content on Critical Surfaces
- f) The Contractor shall identify the standard for test methods for environmental engineering in **DRD CEV-T-073, Environmental Control and Life Support Design and Data Book**. This standard shall meet or exceed the following standard:
  - MIL-STD-810F, DOD Test Method Standard for Environmental Engineering Considerations and Laboratory Tests, Section 5 and Part 2.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

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- DRD CEV-T-073: Environmental Control and Life Support Design and Data Book
- DRD CEV-T-074: Habitation Accommodations Design and Data Book

**6.2.10 Pyrotechnics**

- a) NASA will supply the pyrotechnic initiators for all pyrotechnic events excluding non-Shuttle mechanically initiated devices for crew escape. NASA will supply interface and performance requirements for the system used to fire the initiators.
- b) If the Contractor selects existing Shuttle pyrotechnic devices for the CEV Spacecraft, then NASA will supply those pyrotechnic devices to the Contractor.
- c) NASA will supply all pyrotechnics used on the parachute system.
- d) The Contractor shall comply with all requirements in JSC 62809, NASA Human Rated Spacecraft Pyrotechnic Specification.
- e) The Contractor shall perform preliminary design reviews and critical design reviews for all pyrotechnic devices not provided by NASA. The Contractor shall conduct development, qualification, and acceptance testing on all other pyrotechnic devices selected for the CEV Spacecraft. The Contractor shall conduct Phase I, Phase II, and Phase III technical reviews on all other pyrotechnic devices selected for the CEV Spacecraft per the requirements of JSC 62809, NASA Human Rated Spacecraft Pyrotechnic Specification.
- f) The Contractor shall perform stress analysis and deliver stress analysis reports (**DRD CEV-T-062, Stress Analysis Report**) on all pyrotechnic devices selected for the CEV Spacecraft.
- g) The Contractor shall use the following standards for designing the pyrotechnics subsystem:
  - AFJMAN 24-204, Preparing Hazardous Materials for Military Air Shipments
  - FED-STD-H28/20, Screw - Thread Standards for Federal Services Revision A or Later Inspection Section 20 Methods for Acceptability of UN, UNR, UNJ, M, and MJ Screw Threads
  - JSC 20431, NASA JSC Neutron Radiography Specification
  - JSC 62809, NASA Human Rated Spacecraft Pyrotechnic Specification
  - JSC/SKD 26100132, Performance Specification for NSTS Use of Percussion Primers
  - MIL-DTL-398, RDX (Cyclotrimethylenetrinitramine)
  - MIL-DTL-45444, HMX (Cyclotetramethylenetetranitramine)
  - MIL-L-3055, Type I Lead Azide
  - MIL-L-46225, Lead Azide RD-1333
  - MIL-P-20444C, Primer, Percussion, M42 Parts for and Loading, Assembling and Packaging
  - MIL-P-387, Pentaerythrite Tetranitrate (PETN)
  - MIL-STD-286, Military Standard Propellants, Solid: Sampling Examination and Testing; Method 802.1
  - WS 5003F, Material Specification for HNS Explosive
- h) The Contractor shall identify their standards for designing the pyrotechnics subsystem, in the following areas. This standard shall meet or exceed the following standards:
  - AIA/NAS NASM20995, Wire, Safety or Lock
  - ANSI/ASQC Z1.4, Sampling Procedures and Tables for Inspection by Attributes

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- ANSI/NCSL Z450-1, Calibration Laboratories and Measuring and Test Equipment - General Requirements
- ASTM E1742, Standard Practice for Radiographic Examination
- ASTM E8, Standard Test Methods of Tension Testing of Metallic Materials
- DOD 4145.26-M, DOD Contractors Safety Manual for Ammunition and Explosives
- MIL-P-116, Preservation, Methods of
- MIL-S-22473, Sealing, Locking and Retaining Compounds, Single Component
- MS20003, Indicator, Humidity, Card, Three Spot, Impregnated Areas

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-075: Pyrotechnic Subsystem Design and Data Book

**6.2.11 Landing and Recovery System**

- a) NASA will provide the parachute system.
- b) NASA will perform advanced development of the landing attenuation system leading up to the landing attenuation system subsystem PDR.
- c) NASA will produce the following landing attenuation system PDR products:
  - Landing Attenuation System Subsystem Requirements Specification (**DRD CEV-T-031**, CEV <Subsystem> Requirements Specification)
  - Landing Attenuation System Component Requirements Specification (**DRD CEV-T-031**, CEV <Component> Requirements Specification)
  - Input to **DRD CEV-T-076**, Recovery Systems Design and Data Book
  - Input to **DRD CEV-T-077**, Recovery Systems Simulation Models and Documentation
- d) The Contractor shall participate in the advanced development activities to the extent necessary to execute the efforts described in this SOW.
- e) The Contractor shall produce all remaining PDR products not produced by NASA.
- f) The Contractor shall complete design, development, test, certification, and delivery of the selected landing attenuation system and all post-PDR DRD products.
- g) The Contractor shall perform the requirements development, trade studies, design, analysis, production, assembly, integration, testing, verification, validation, qualification, certification, and maintenance for Contractor-provided CEV recovery hardware as specified by the CEV Project.
- h) The Contractor shall develop models and simulations for Contractor-provided hardware and integrate with the models and simulations for the NASA-provided hardware to support recovery systems development (**DRD CEV-T-077**, Recovery System Simulation Models and Documentation).

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-076: Recovery Systems Design and Data Book
- DRD CEV-T-077: Recovery Systems Simulation Models and Documentation



#### **6.2.12 Guidance, Navigation, and Control (GN&C)**

- a) The CEV GN&C requirements design and functional verification effort will be performed through the use of specialized mode teams. NASA will lead and the Contractor shall participate in each of these teams through the development of detailed design requirements for the CEV GN&C flight system. The Contractor shall document the GN&C requirements in **DRD CEV-T-031**, *CEV GN&C Subsystem Requirements Specification*, and **DRD CEV-T-048**, *GN&C Software Requirements Specification*. The Contractor shall provide support to the following teams:
- o CEV Ascent/Abort Mode Team
  - o Entry GN&C Mode Team
  - o On-Orbit GN&C Mode Team
  - o Flight Mechanics/Mission Design Mode Team

##### ***Deliverables***

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-078: GN&C Design and Data Book

#### **6.2.13 Wiring**

- a) The Contractor shall develop and document the process for defining, fabricating, testing, routing, installing, verifying, and maintaining the CEV wiring subsystem throughout the life cycle, including vehicle modifications, upgrades, and discrepancy resolution. This process shall be documented in the **DRD CEV-T-079**, *CEV Wiring Plan*.
- b) The Contractor shall develop a wiring database that provides definition down to the level of pin-to-pin connectivity for all electrical harnesses and optical cables used on the CEV for ground, launch, flight, and recovery operations including testing, verification, calibration, and maintenance. The Contractor shall deliver the wiring database to NASA as **DRD CEV-T-080**, *CEV Wiring Database and Reports*. The Contractor shall provide a hierarchical path/signal structure which links the wiring database to **DRD CEV-T-046**, *CEV Data and Command Dictionary*.
- c) The Contractor shall develop, manufacture/fabricate, test, install, and certify all vehicle wiring in accordance with **DRD CEV-T-079**, *CEV Wiring Plan*, and **DRD CEV-T-080**, *CEV Wiring Database and Reports*.

##### ***Deliverables***

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-079: CEV Wiring Plan
- DRD CEV-T-080: CEV Wiring Database and Reports

#### **6.2.14 Launch Abort System**

- a) Development of unique launch abort system components and integration of all other subsystem components that make up the abort system is the responsibility of the launch abort system team.

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- b) The Contractor shall develop and use integrated models with sufficient fidelity to allow accurate trades to be performed for the design and development of the launch abort system to meet the requirements specified by the CEV Project.
- c) The Contractor shall provide the launch abort system for the CEV launch abort flight tests and flight vehicles.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-081: Launch Abort System Design and Data Book

**6.3 Reserved****6.4 Spacecraft Integration and Test Facilities**

- a) The Contractor shall provide the Integration, Test, & Verification (IT&V) facilities required to complete integrated verification of the spacecraft. The requirements for the IT&V facilities shall be derived from the products developed under Section 6.1.4, Spacecraft Test, Verification and Certification.
- b) NASA will lead, and the Contractor shall participate in, the development of detailed requirements for the CEV Avionics Integration Lab (CAIL). The purpose of the CAIL is to perform integration testing of the CEV avionics hardware and software and associated internal and external CEV interfaces using flight avionics hardware, flight software, and an appropriate suite of certified ground support tools/systems and software. The Contractor shall document the CAIL requirements in **DRD CEV-T-082, Spacecraft Test & Verification Facility System Requirements Document**, the CAIL design in **DRD CEV-T-083, Spacecraft Test & Verification Facility System Design Document**, the CAIL certification plan in **DRD CEV-T-084, Spacecraft Test & Verification Facility Certification Plan**, and the CAIL certification results in **DRD CEV-T-085, Spacecraft Test & Verification Facility Certification Package**.
- c) The Contractor shall perform requirements development (with NASA participation and concurrence), design, integration, delivery of EPS generation/storage/distribution/control equipment, verification, validation, qualification, and certification for a CEV Exploration EPS Testbed (EEST). The Contractor shall document the CEV EEST requirements in **DRD CEV-T-082, Spacecraft Test & Verification Facility System Requirements Document**, the CEV EEST design in **DRD CEV-T-083, Spacecraft Test & Verification Facility System Design Document**, the CEV EEST certification plan in **DRD CEV-T-084, Spacecraft Test & Verification Facility Certification Plan**, and the CEV EEST certification results in **DRD CEV-T-085, Spacecraft Test & Verification Facility Certification Package**.
- d) The Contractor shall develop a CAIL that at a minimum includes the following:
  - A certified flight hardware suite representing the CEV Spacecraft avionics (down to the firmware-level).
  - A simulator (including hardware, software, and interfaces) certified to represent the flight environment needed to verify the end-to-end performance of the data processing system.
  - Test capabilities to perform integrated verification.
  - Integration of the above items.
  - Interfaces to Constellation element emulators.
- e) The Contractor shall develop an EEST that at a minimum includes the following:
  - CEV electrical test bed design for use in a NASA provided and operated facility.

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- Functionally flight equivalent to the CEV and reconfigurable to match any CEV block designs.
  - Certified flight-like hardware for the power generation, storage, and distribution/control subsystems; however, flight performance equivalent emulators can be substituted for the power generation and storage subsystems.
  - Electrical load simulation (including hardware, software, and interfaces) to represent the flight environment needed to verify the end-to-end performance of the EPS system.
  - Test capabilities, to perform integrated verification, which accommodate the electrical testing of:
    - CEV-contractor provided equipment
    - Integrated or portable internal/external GFE and payload electrical equipment
    - CEV electrical interfaces required for ground maintenance, launch support, and other in-flight vehicles
    - Nominal and off-nominal testing (includes destructive testing with provisions to isolate and protect the integrity of the test-bed)
    - CEV-integrated EPS with critical test-point measurements without adversely affecting certified flight-like performance
  - Integration of the above items.
- f) The Contractor shall develop, install, certify, and deliver the CAIL, including all applicable operating procedures, instructions, and drawings, to NASA at a site to be chosen by NASA in a TBD location in Houston, Texas. The CAIL shall include two full operational rigs and a third development rig. The Contractor shall begin delivery of these three rigs to the CAIL facility at CDR and have these rigs fully operational no later than six months after CDR.
- g) The Contractor shall develop, install, certify, and deliver the EEST, including all applicable operating procedures, instructions, and drawings, to NASA at a site to be chosen by NASA in a TBD location in Houston, Texas.
- h) The Contractor shall design the CAIL and EEST to be reconfigurable for all spacecraft configurations (Block 1A, 1B, and 2).
- i) The Contractor shall deliver the following:
- CAIL
  - EEST
  - *Acceptance Data Packages (DRD CEV-T-040)*
    - CAIL
    - EEST
  - DD250 for each of the above

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-082: Spacecraft Test & Verification Facility System Requirements Document
- DRD CEV-T-083: Spacecraft Test & Verification Facility System Design Document
- DRD CEV-T-084: Spacecraft Test & Verification Facility Certification Plan
- DRD CEV-T-085: Spacecraft Test & Verification Facility Certification Package

## 6.5 *Spacecraft Assembly, Integration, and Production*

- a) The Contractor shall integrate, assemble, certify, acceptance test, and deliver flight spacecraft meeting the requirements for the particular configurations below.
- b) The Contractor shall test (acceptance test only) and deliver flight spares. The Contractor shall provide a spare parts list as part of the **DRD CEV-T-012, Logistics Support Analysis (Recommended Spare Parts List)**. (IDIQ)
- c) The Contractor shall integrate, assemble, acceptance test, and deliver flight test articles meeting the standards and requirements of section 10.1, Flight Test Article Development and Production. Note: Flight test articles do not need to meet the standards levied in section 6.0, Spacecraft.
- d) NASA will define the maturity and quality of the early software deliveries to external sources (e.g., the training facility and simulators) needed for development of NASA facilities, including ground rules for submitting discrepancies and measuring the quality of the software development process. NASA will have the final decision authority on the content of all software deliveries to external sources. The Contractor shall produce *Software Version Description Documents (DRD CEV-T-057)* for each external software delivery detailing requirements capabilities satisfied with each software release. The Contractor shall be responsible for providing load support with all external flight software deliveries. Additionally, the Contractor shall be responsible for providing all software utilities, special test equipment, and associated user's manuals required for loading software in delivered Line Replaceable Units (LRUs). The Contractor shall begin delivery of software loads to external sources six months after CDR and shall occur every following nine months until contract completion.
- e) The Contractor shall develop and implement plans detailing the design and construction of all CEV transportation support equipment, and the plans for transportation of the CEV Spacecraft to the processing and/or launch sites. These plans shall be included in **DRD CEV-T-087, CEV Spacecraft Handling and Transportation Plan**.
- f) The Contractor shall provide to NASA test equipment, facilities, tooling or fixtures required for producing and testing mission-cycle flight articles.
- g) The Contractor shall develop and implement an imagery plan to provide imagery (e. g., still photo, motion picture, digital imagery, or video) of the CEV Spacecraft system, modules, subsystems, and components during manufacturing, assembly, test, integration, and close-out to document the hardware configuration. The Contractor shall include the plan and imagery in **DRD CEV-T-088, CEV Imagery Plan/Imagery Deliverables**.
- h) The Contractor's delivery plans shall include the planned method of manufacturing (including the Contractor's plans for design for manufacturability) and assembly of the flight articles(s) and associated unique tooling, fixtures and support and test equipment in accordance with **DRD CEV-T-086, Manufacturing and Assembly Plan**.
- i) The Contractor shall be responsible for maintaining all trainer-delivered hardware for assurance that the hardware receives all upgrades and all fixes.
- j) The Contractor shall deliver the following:
  - o 2 Flight Spacecraft
    - 1A: Crew Module + DD250; Service Module + DD250; LAS + DD250; Spacecraft Adapter + DD250
    - 1B: Crew Module + DD250; Service Module + DD250; Spacecraft Adapter + DD250
  - o 2 Additional Production CEVs with requirements as defined in Section 10.0, Flight Test
    - RRF<sub>1</sub> Crew Module + DD250; Service Module + DD250; LAS + DD250; Spacecraft Adapter + DD250

- ## ***Deliverables***

- DRD CEV-T-086: Manufacturing and Assembly Plan
- DRD CEV-T-087: CEV Handling and Transportation Plan
- DRD CEV-T-088: CEV Imagery Plan/Imagery Deliverables

## 7 OPERATIONS

CEV Operations is a NASA-led function with the Contractor providing the necessary data products, operational requirements, and support for NASA to develop the plans, processes, procedures, and tools to operate the CEV System. Operations includes the development and implementation of the processes, plans, system requirements, support and reference documents, training, procedures, and work associated with the preparation, launch and flight execution, and recovery of the CEV spacecraft. The scope of operations includes use of the CEV System hardware/software after delivery to NASA in support of the preparation and execution of the Risk Reduction Flights (RRF) \_\_\_\_\_ as defined in SOW Section 10, Flight Test, and the operational flights.

The two principle areas of operations are ground operations and flight operations. Ground operations are activities associated with the processing of the flight hardware using ground systems for the launch and post-landing operations. These activities include the planning, pre-launch processing, launch, and post-landing operations. Flight operations are activities performed to support the spacecraft and crew to accomplish the mission objectives. The scope of flight operations includes the early preflight analyses and design, flight planning, flight product and procedure development, flight training, and flight execution by the crew and mission operations.

- a) The Contractor shall provide a concept of operations for the CEV in accordance with **DRD CEV-O-001**, *Contractor's CEV Concept of Operations*, using ANSI/AIAA-G043-1992, Guidance for the Preparation of Operational Concept Documents, paragraph 4.0 and Appendix A, as a guidance document.

### **Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-O-001: Contractor's CEV Concept of Operations

## 7.1 Operational Analyses Supporting Design

- a) The Contractor shall perform and update operational analyses \_\_\_\_\_ for implementation per SOW Sections 2.1.5, Systems Analysis, 2.2.1, CEV to Constellation Program Integration, and 2.2.2, CEV to ISS Program Integration in accordance with **DRD CEV-T-010**, *System Performance Analysis Report*, to ensure a balance of cost, schedule and risk between spacecraft design and ground and flight infrastructure needed to accomplish the operational mission. These operational analyses will produce an "operational view" that describes how the system products serve the operators (e.g. flight crew, ground operations, and flight operations). The Contractor shall provide operational analyses that establish lifecycle operation and support requirements for the system. These operational analyses shall be sufficient for use by NASA to determine how best to provide operational support, determine under what environmental conditions the system products may be used, and how well they may perform under anticipated conditions. The Contractor shall incorporate the applicable human-to-machine interface considerations for ground processing from the CXP-01000, Constellation Human System Integration Requirements (HSIR) (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List). Example subjects for operational analyses include:
- Reduction and consolidation of flight-to-ground interface points in addition to flight-element to flight-element interfaces;
  - Use of common/consistent fasteners, connectors, and consumables/propellants;
  - Use of non-toxic consumables;

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- Design of Line Replaceable Units (LRUs) that allows for removal, replacement and retest throughout the ground processing flow;
- Use of design that allows for in-space maintenance;
- Minimize operational constraints on vehicle in-space attitudes caused by design limitations in such systems as communications, thermal, or power system; and
- Design of flight software architecture for less costly maintenance and certification following updates.

## **7.2 Ground Operations**

Ground Operations will be the responsibility of the NASA; however, it is essential that the Contractor participate with NASA in the overall planning and implementation of ground operations.

- a) The Contractor shall support NASA ground operations in the development of a CEV ground operations plan addressing pre-launch processing, launch operations, and post-landing operations to ensure that ground operations activities are appropriately planned and implemented. Examples of Contractor support to NASA ground operations include: provide flight and ground design data, provide technical assistance to the system integrated testing approach, identify support requirements for vehicle processing, provide technical expertise during the operations reviews, and provide work force resource loading forecasts for ground operations activities involving Contractor-provided hardware and software. (IDIQ)
- b) The Contractor shall develop and update the flight hardware/software operations and maintenance plans and requirements for ground operations in accordance with **DRD CEV-O-002, Flight Hardware/Software Operations and Maintenance Requirements Development Plan and Requirements Document**. The Contractor shall coordinate flight hardware/software operations and maintenance plans and requirements development with NASA.
- c) The Contractor shall provide flight and ground hardware/software technical assistance during ground operations phases to support ground operations activities, ensure operations and maintenance requirements implementation, assist in element-to-element integrated testing, assist in flight hardware/software corrective action disposition, ensure consistent, clear communications between the Contractor and NASA ground operations, and provide an advocate between the ground operations organizations and the spacecraft designers. (IDIQ)
- d) NASA will implement the requirements as defined in the **DRD CEV-O-002, Flight Hardware/Software Operations and Maintenance Requirements Development Plan and Requirements Document**, during ground operations. The Contractor shall assess and provide recommendations regarding changes to the NASA-developed ground operations procedures to assure that the changes are consistent with the CEV Spacecraft and GSE requirements, constraints, and capabilities. (IDIQ)
- e) For work that is to be accomplished by the Contractor at either KSC or CCAFS, the Contractor shall develop and update the support requirements in compliance with KSC-HB-GP60-3 ASRS Handbook and in accordance with **DRD CEV-O-003, Launch Site Support Requirements Documentation**.
- f) The Contractor shall be responsible for post-flight refurbishment of any reusable items delivered under Schedule A. (IDIQ)

### **Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-O-002: Flight Hardware/Software Operations and Maintenance Requirements Development Plan and Requirements Document

## Crew Exploration Vehicle – (CEV)

- DRD CEV-O-003: Launch Site Support Requirements Documentation

### 7.3 Flight Operations

Flight Operations include the plans, processes, schedules, and products required to perform the flight design, analyses, and flight planning activities; flight products and procedure development; and execution of the Risk Reduction Flights (RRF), as defined in SOW Section 10, Flight Test, and the operational flights. Flight operations will be the responsibility of NASA; however, it is essential that the Contractor provide the data and support to NASA for the development of the flight operations products to prepare for and execute the CEV missions.

#### 7.3.1 Flight Operations Preparation

Flight Operations Preparation is the development of the pre-flight plans, processes, schedules, flight design and analyses, flight plans, procedures, and support products necessary to prepare for the CEV mission execution. The culmination of these activities will produce a complete, integrated set of operations products and procedures necessary to execute a CEV mission.

A single authoritative source of vehicle design and performance data is required to develop, produce, and implement the flight design process, trade studies, analyses, simulations, and flight products and procedures.

- a) The Contractor shall develop and update vehicle systems, flight design, and analysis data for the CEV spacecraft in accordance with **DRD CEV-O-004, CEV Operations Data Book**,
  - o Volume I: CEV Spacecraft Systems Performance and Constraints Data
  - o Volume II: CEV Spacecraft Systems Electrical Equipment List
  - o Volume III: CEV Mission Mass Properties Data
  - o Volume IV: CEV Spacecraft Systems Contingency Analysis Data
  - o Volume V: CEV Aerodynamic and Astrodynamics Performance and Constraints Data
  - o Volume VI: CEV Crew Module Landing and Emergency Rescue Data
  - o Volume VII: CEV Flight Capability Envelopes
  - o Volume VIII: CEV Ascent, Entry, and On-orbit Structural Envelopes
- b) The Contractor shall develop the initial procedures inputs in accordance with **DRD CEV-O-005, Flight Operations Procedures Data**. These provide nominal operations, maintenance, and nominal/off-nominal time critical response CEV spacecraft procedure inputs.
- c) The Contractor shall develop the CEV stowage procedures and supporting documentation in accordance with **DRD CEV-O-006, CEV Stowage Capabilities and Services Handbook**.
- d) The Contractor shall provide support to the NASA flight operation's systems, flight planning and cargo integration, and flight design and analysis disciplines. The Contractor shall ensure consistent, clear communications between the Contractor and NASA flight operations, and shall research and disseminate the necessary data and technical information from the spacecraft designers for NASA to develop its flight products. Examples of Contractor support to NASA flight operations include: provide technical assistance during NASA's development of the flight crew and flight controller procedures, flight rules, flight plans, system briefs, reference products, flight design and analysis tools, system analysis tools, telemetry parameter selection, displays necessary to prepare for and execute CEV flight operations, and provide an advocate between the flight operations organizations and the spacecraft designers. (IDIQ)



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- e) The Contractor shall assess and provide recommendations regarding flight rule change requests and procedures change requests to assure that changes are consistent with CEV spacecraft requirements, constraints, and capabilities. (IDIQ)

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-O-004: CEV Operations Data Book
- DRD CEV-O-005: Flight Operations Procedures Data
- DRD CEV-O-006: CEV Stowage Capabilities and Services Handbook

**7.3.2 Flight Operations Execution (IDIQ)**

Flight Operations Execution encompasses real-time support for all phases of mission operations beginning with pre-launch activities through post-landing egress of the flight crew. It is the culmination of all of the earlier pre-flight flight design, mission planning, training, and ground operations activities.

- a) The Contractor shall provide support during the execution of the CEV missions using the Contractor personnel supporting the NASA flight operation's systems, flight planning and cargo integration, flight design and analysis, and training disciplines.
- b) The Contractor shall provide engineering support during flight execution to provide technical information, interpret systems health data, and perform in-depth analysis in response to anomalous spacecraft conditions. The Contractor shall support the NASA CEV sub-system managers.

**7.4 Range Safety**

Test and operational flights of the CEV from U.S. airspace and ranges will require interaction with the agency responsible for the range. Support to Range Safety includes the technical and management efforts to assemble the appropriate team; develop and prepare plans for compliance with range safety requirements during design, development, preparation and execution of CEV test and operational flights; establish meetings and reviews with range safety personnel and the CEV subsystems personnel; coordinate with NASA operations personnel; and obtain range safety support to hazardous activities at the launch and test flight sites, launch operations, and hazards analysis for the launch/ascent and the descent/landing phases.

- a) In association with the CLV Project and the launch vehicle contractors, the Contractor shall define and resolve range safety issues in support of CEV system development, and provide data necessary to gain approval of the range safety requirements in accordance with **DRD CEV-O-007**, *Range Safety Requirements Documents* using NPR 8715.5, Range Safety Program, and AFSPCMAN 91-710, Range Safety User Requirements Manual. The Contractor shall incorporate the requirements set developed in accordance with **DRD CEV-O-007** into the appropriate CEV Spacecraft and GSE specifications delivered in **DRD CEV-T-031**, *CEV <System> Requirements Specification*.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-O-007: Range Safety Requirements Documents

## **7.5 Training**

NASA operations will develop the training products and conduct the operations training and certification for ground and flight operations.

- a) The Contractor shall provide NASA operations access to all data products produced by the Contractor, its subcontractors, and its vendors for the purpose of their in-house training and familiarization of the CEV System and its subsystems. The Contractor shall provide the data products in accordance with SOW Section 1.1.3, NASA ICE.
- b) For ground operations, the Contractor shall provide support for NASA development of training materials. Examples of Contractor support include: provide technical assistance in flight hardware processing, handling, and safety considerations; and provide an advocate between the ground operations' training organization and the spacecraft designers. (IDIQ)
- c) For flight operations, the CEV Contractor shall provide support to the NASA training organization. The Contractor shall ensure consistent, clear communications between the Contractor and the NASA training organization, and shall provide technical assistance during NASA's development of the training materials necessary to prepare the flight crew, flight controllers, and other flight operations personnel for CEV missions. Examples of Contractor support include: research and dissemination of the necessary vehicle systems data and technical information from the spacecraft designers for NASA to develop its training products; provide preliminary vehicle design and test data, vehicle design rationale and drivers, and clarify vehicle requirements, design, and interfaces; and provide an advocate between the flight operations' training organization and the spacecraft designers. (IDIQ)

**8 LAUNCH AND VEHICLE SERVICES (RESERVED)**

## **9 GROUND AND TRAINING SYSTEMS**

Ground Systems include facilities, facility systems, and support equipment hardware and software required for ground and flight operations. NASA will provide all ground systems facilities, facility systems, and a portion of the support equipment.

Training Systems include facilities, hardware and software to support ground and flight operations training. NASA will provide training systems.

### **9.1 Facilities and Facility Systems**

The ground facilities and facility systems encompass processing facilities, control rooms, landing and recovery facility systems and other monitoring systems.

- a) The Contractor shall develop and update end item-level requirements in accordance with **DRD CEV-O-008**, *Ground Systems Requirements, Plans, Reports, and Design Data, Volume I, Ground Systems End Item Requirements Document and Report*.
- b) The Contractor shall support NASA in the requirements development; and in the design, development, modification, and implementation activities for the facilities and facility systems that will be provided by NASA. Examples of Contractor support include: provide flight hardware/software interface design and data; participate in the design reviews, working groups, and technical interchange meetings; ensure Contractor requirements are implemented appropriately; and participate in the activation and verification of NASA provided facilities and facility systems. (IDIQ)

#### **Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-O-008: Ground Systems Requirements, Plans, Reports and Design Data

### **9.2 Ground Support Equipment**

Ground Support Equipment (GSE) includes hardware and software needed for ground operations.

- a) The Contractor shall support NASA in developing the allocation list of GSE to be provided by the Contractor. The allocation list will include GSE end items required to support SOW Sections 6.1.4, Spacecraft Test, Verification, and Certification, 7.2, Ground Operations, and 10.0, Flight Test. The Contractor shall identify all Contractor-provided GSE in Attachment J-9, Deliverable Items List. The NASA-provided GSE described in Attachment J-11, Government Furnished Property List, will be delivered to NASA ground operations for the RRF and operational flights. Contractor use of the NASA-provided equipment will be determined during the allocation list development. Examples of the types of GSE to be provided by the Contractor include:
  - o Lifting Devices – Contractor to provide lifting slings and adapters from Hydraset down to spacecraft elements/components
  - o Fluid and Gases Servicing Systems – Contractor to provide spacecraft interfacing connections
  - o Command, Control and Monitoring System – Contractor to provide CEV standalone Command, Control and Monitoring System
  - o Facility Infrastructure Systems – Contractor to provide spacecraft specialty systems (Spacecraft specific special electrical power supplies, data handling, etc.)
  - o Access stands – Contractor to provide internal access equipment

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- Special tools – Contractor to provide spacecraft specific special tools and ancillary equipment (LRU installation and removal devices and tools, inspection tools, )
- Special Test equipment – Contractor to provide special test equipment (Cabin Leak test equipment, Data bus test equipment, etc.)
- b) The Contractor shall develop and update the GSE SRD in accordance with **DRD CEV-T-031**, *CEV <System> Requirements Specification*, for Contractor-provided GSE. The Contractor shall ensure that the GSE SRD is consistent with **DRD CEV-O-001**, *Contractor's CEV Concept of Operations*, and ground systems defined in **DRD CEV-O-008**, *Ground Systems Requirements, Plans, Reports and Design Data*, and balances performance, life-cycle cost, schedule, and risk. The Contractor shall develop and update the **DRD CEV-T-035**, *Internal Interface Requirements Document*, for all interfaces with flight hardware, NASA and Contractor-provided GSE, facility systems, and facilities.
- c) The Contractor shall develop and update the end item-level requirements in accordance with **DRD CEV-O-008**, *Ground Systems Requirements, Plans, Reports, and Design Data, Volume I, Ground Systems End Item Requirements Document and Report*. The Contractor shall use the following applicable documents:
  - NASA-STD-5005B: NASA Standard for Ground Support Equipment (and associated Applicable Document Children as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List).
- d) The Contractor shall design, develop, produce, integrate, verify, validate, certify, document, and deliver CEV GSE in accordance with all requirements in CXP-10001, *Systems Requirements for the Crew Exploration Vehicle Element (CEV-SRD)*, and in this SOW, and in accordance with **DRD CEV-O-008**, *Ground Systems Requirements, Plans, Reports, and Design Data, Volume II, Ground Systems End Item Implementation Plan and Report*.

The Contractor shall plan for and deliver the GSE end items 90 days prior to first need date. The Contractor shall use the following applicable documents for design and development of Contractor-provided GSE:

- NASA-STD-5005B: NASA Standard for Ground Support Equipment (and associated Applicable Document Children as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List).
- e) The Contractor shall develop, update, and implement the approach for Contractor-provided GSE software test, verification, and integration test and support of hardware/software and vehicle integration test activities, in accordance with the **DRD CEV-T-052**, *Software Test Plan*.
- f) The Contractor shall support NASA in the requirements development, design, modification, and implementation activities for the GSE that will be provided by NASA. Examples of Contractor support include: provide flight hardware/software interface design and data; participate in design reviews, working groups, and technical interchange meetings; ensure Contractor requirements are implemented appropriately; and participate in the test and verification of the NASA-provided GSE. (IDIQ)
- g) The Contractor shall develop and update **DRD CEV-O-008**, *Ground Systems Requirements, Plans, Reports, and Design Data, Volume III, Systems Operations and Maintenance Plan and Requirements Documentation*, for the ground support equipment provided by the CEV Contractor.
- h) The Contractor shall develop, maintain and deliver all technical models and drawings of the GSE associated with the CEV Project in accordance with **DRD CEV-T-003**, *CEV CAD Models*, and **DRD CEV-T-004**, *CEV Drawings*.

## Crew Exploration Vehicle – (CEV)

- i) The Contractor shall perform and document GSE FMEA/CIL in accordance with **DRD CEV-S-009, Failure Modes Effects Analysis & Critical Items List (FMEA/CIL)**.
- j) The Contractor shall develop, organize, and deliver safety data packages per **DRD CEV-S-003, System Safety Hazard Analyses**, in accordance with the project schedule and CXP-02012, Methodology for Conduct of Project Constellation Hazard Analyses.
- k) The Contractor shall develop and update 2-D and 3-D simulation models of the Contractor-provided spacecraft and Contractor-provided GSE to assess clearances, placement, conflicts and the moving of hardware in accordance with **DRD CEV-T-003, CEV CAD Models**. The Contractor shall develop and deliver these models in accordance with SOW Section 2.1.2.
- l) The Contractor shall design, develop, produce, integrate, verify, validate, certify, maintain, document, and deliver CEV GSE software in accordance with all requirements in CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD) and in this SOW.
- m) The Contractor shall ensure that ground systems software complies with standards identified in SOW Section 2.1.4, Software Engineering. For ground operations, the Contractor shall develop and update the software and interface requirements specifications for Contractor-provided ground systems software in accordance with **DRD CEV-T-048, Software Requirements Specification**, and implement the design processes and plans documented in the **DRD CEV-T-005, Software Development Plan**.
- n) The Contractor shall allocate the requirements of each Computer Software Configuration Item (CSCI) to the Computer Software Components (CSCs) and Computer Software Units (CSUs) levels for Contractor-provided GSE. The Contractor shall document the software design breakdown in accordance with the **DRD CEV-T-029, Interface Control Documents**, and **DRD CEV-T-050, Software Design Description**.
- o) The Contractor shall develop, update, and implement a GSE MVP for the approach, requirements, implementation strategies and associated test documentation to test, verify, activate, and qualify Contractor-provided GSE in accordance with **DRD CEV-T-015, Master Verification Plan**.
- p) The Contractor shall perform unit testing of the GSE software. Unit test procedures (CSU-level), CSU-to-CSU interface, CSC-level, and CSC-to-CSC interface tests will not be a deliverable to NASA; however, they shall be made available to NASA upon request via **DRD CEV-T-007, Software Development Folders**. All CSCI-level test procedures shall be documented in **DRD CEV-T-053, Software Test Description**. The Contractor shall develop and deliver **DRD CEV-T-017, Certification Data Package**, for each CSCI and for the integrated GSE software. The Contractor shall develop and deliver **DRD CEV-T-040, Acceptance Data Package**, for each GSE software deliverable.
- q) The Contractor shall develop and update **DRD CEV-O-008, Ground Systems Requirements, Plans, Reports, and Design Data, Volume IV, Ground Systems Sustaining Engineering Plan**, for the Contractor-provided GSE.
- r) NASA will perform the GSE sustaining engineering activities. The Contractor shall support NASA sustaining engineering activities. Examples of Contractor support include: provide engineering support for problem resolution including Material Review Board (MRB) items; provide engineering review and analysis of proposed upgrades and modifications; review FMEA-CIL and hazard analysis identified critical items for mitigation or elimination; and provide an advocate between the ground operations organizations and the GSE designers. (IDIQ)
- s) The Contractor shall develop and deliver **DRD CEV-T-040, Acceptance Data Package**, for each Contractor-provided GSE end item.
- t) The Contractor shall provide initial spares, concurrent with the delivery of the GSE end items and in accordance with the provisioning procedures in **DRD CEV-T-011, Integrated Logistics**

*Support Plan*, and **DRD CEV-T-012, Logistics Support Analysis**, for all Contractor-provided GSE. (IDIQ)

- u) The Contractor shall complete the DD-250 for the Contractor-provided GSE and deliver the Contractor-provided GSE to the NASA-designated facilities.

### **9.3 Training Systems (IDIQ)**

NASA will provide the Training Systems necessary to prepare the crew, ground, and flight operations personnel for successful execution of CEV missions.

- a) For ground operations training systems, the Contractor shall support NASA in the implementation of the training systems requirements. Examples of the support include: provide flight hardware interface design and data; participate in the design reviews, working groups, and technical interchange meetings; and participate in the test and verification of the NASA-provided training systems.
- b) The Contractor shall provide support to assist NASA's development of the CEV simulators and mockups used for crew and flight controller training, procedure verification, real-time support, and control center testing. Examples of Contractor support include: provide flight hardware interface design and data; participate in the design reviews, working groups, and technical interchange meetings; and participation in the test and verification of the NASA-provided training systems.

### **9.4 Storage**

Ground Systems Storage includes the development of requirements for storage facilities for flight and ground systems and logistical spares provided by the CEV Contractor.

- a) The Contractor shall develop the requirements for the storage of Contractor-provided flight hardware and logistical spares in accordance with **DRD CEV-O-002, Flight Hardware/Software Operations and Maintenance Requirements Development Plan and Requirements Document**.
- b) The Contractor shall develop the requirements for the storage of Contractor-provided ground systems and logistical spares in accordance with **DRD CEV-O-008, Ground Systems Requirements, Plans, Reports, and Design Data, Volume I, Ground Systems End Item Requirements Document and Report**.

## **10 10. FLIGHT TEST**

All flight test activities will be conducted by NASA, as a NASA-provided service to the Contractor for Design, Development, Test, and Evaluation (DDT&E). As the lead for this activity, NASA has defined notional test opportunities for the Launch Abort System (LAS) testing in Table 10.1, and integrated CEV/CLV Risk Reduction Flight (RRF) testing in Table 10.2. The two tables provide conceptual guidance for the complexity required for each test article. The actual complexity required for each test vehicle will be determined by the vehicle design and the required test objectives for each test.

SOW Section 10 covers the work associated with the Launch Abort System (LAS) test 1-3. For this effort, the Contractor shall develop Flight Test Article (FTA) requirements, design, build, verify, and deliver the FTAs appropriate for these tests.

NASA will supply the Abort Test Boosters (ATB) used in LAS tests 2 and 3 as identified in Table 10.1 and as refined by the Contractor. NASA will supply the ATB to Service Module (SM) test article interface adapter.

For RRF<sub>1</sub> and RRF<sub>2</sub> flight tests outlined in Tables 10.1 and 10.2, the Contractor shall define the test-unique production CEV requirements. This requirement set will contain both additional requirements over the production CEV requirements set and requirement deletions from the production CEV requirement set. The requirement definition activity is covered in this section of the SOW. The design, production, assembly, checkout and delivery of the spacecraft for these tests is covered in SOW Section 6, Spacecraft using the modified requirements developed in this section.

A test team led by NASA, with Contractor participation, will coordinate the development and implementation of the Flight Test Program. SOW Section 10 also includes the Contractor support effort associated with LAS 1-3 testing.

The Contractor operations support effort for RRF<sub>1</sub> and RRF<sub>2</sub> is covered in SOW Section 7 Operations. The GSE for LAS 4 and RRF 2 and 3 is covered in SOW Section 9.2 Ground Support Equipment.





Crew Exploration Vehicle – (CEV)

Table 10.2 Risk Reduction Flight Test Matrix

## **10.1 Flight Test Article Development and Production**

### **10.1.1 Flight Test Article Requirements**

- a) The Contractor shall refine the Launch Abort System test opportunities in Table 10.1 and define any additional tests and test conditions necessary to complete the flight test effort for their system. The Contractor shall document the requirements in **DRD CEV-D-001, FTA Definition**.
- b) Based on the flight test opportunities outlined in Table 10.1, Launch Abort System Test Matrix, and Table 10.2, Risk Reduction Flight Test Matrix, and the contractor's flight test refinement, the Contractor shall document the proposed fidelity and number of FTAs to complete the flight test effort and document the requirements in **DRD CEV-D-001, FTA Definition**.
- c) The Contractor shall develop and maintain FTA system requirements for LAS1, 2, and 3 as identified in Table 10.1, Launch Abort Systems Test Matrix, and **DRD CEV-D-001, FTA Definition**. The Contractor shall document the requirements in **DRD CEV-D-002, FTA System Requirements**.
- e) The Contractor shall develop and maintain system, subsystem, and component requirement specifications appropriate for each FTA configuration based on the flight test objectives. The Contractor shall make available bi-directional traceability for these requirements.
- f) The Contractor shall develop and maintain a FTA specification and drawing tree.
- g) The Contractor shall participate in the development of interface requirement documents and interface control documents that, at a minimum, include the following external interfaces:
  - o FTA to Abort Test Booster (ATB)
  - o FTA to Pad Abort Test Facility
  - o FTA to CLV (RRF1 Test )
  - o FTA to Flight Test Range
- h) NASA will define and document the ATB-induced environments for design. The Contractor shall participate in the ATB-induced environments definition.
- i) The Contractor shall design the FTAs for the specific natural environments and induced environments that the FTA must operate within and for which the FTA must be qualified, encompassing all phases of FTA production, testing and operation in all modes through disposal in accordance with CXP-00102, Constellation Program Design Specification for Natural Environments (DSNE) (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List) utilizing the CXP-05000, Constellation Program Natural Environment Definition for Design (NEDD).
- j) The Contractor shall develop and maintain system requirements for the CEV for [redacted]. It is expected that the [redacted] CEV will have additions and deletions from the CEV System Requirements as defined in Section 2.3 Requirements Definition and Management and Section 6.1.1 Requirements Definition and Management. The Contractor shall document the requirements in **DRD CEV-D-003 CEV RRF [redacted] System Requirements**.
- k) The Contractor shall develop and maintain system requirements for the CEV for RRF 2. It is expected that the RRF 2 CEV will have additions and deletions from the CEV system requirements as defined in Section 2.3 Requirements Definition and Management and

Section 6.1.1, Requirements Definition and Management. The Contractor shall document the requirements in **DRD CEV-D-003**, *CEV, RRF, System Requirements*.

**Deliverables**

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-D-001: Flight Test Article (FTA) Definition
- DRD CEV-D-002: Flight Test Article (FTA) System Requirements
- DRD CEV-D-003: CEV RRF System Requirements

**10.1.2 Flight Test Article Design and Production**

- a) The Contractor shall design, develop, certify, produce, and deliver FTAs for the flight test defined in **DRD CEV-D-002**, *FTA System Requirements*, and the requirements in this SOW.
- b) The Contractor shall define the FTA System Command, Control, Communications, and Information (C3I) interoperability interfaces per **DRD CEV-T-047**, *Avionics Design and Data Book Volume V - Avionics Subsystem - Constellation C3I Interoperability Report*.
- c) The Contractor shall conduct, at a minimum, FTA System Definition Review, FTA System Requirements Review, FTA Critical Design Review, FTA System Acceptance Review for each FTA; and support LAS Test Readiness Reviews, and RRF Readiness Reviews.
- d) The Contractor shall design and develop the FTA software and accompanying test software as required for each FTA.
- e) The Contractor shall develop the FTA software and accompanying test software per NPR 7150.2, NASA Software Engineering Requirements using class C and class D definitions and requirements for this software.
- f) The Contractor shall maintain the FTA software and accompanying test software until the completion of testing as determined by the flight test matrix.
- g) The Contractor shall document production and S&MA standards per **DRD CEV-D-004**, *FTA Engineering Design Data Book*.
- h) The Contractor shall ensure that the FTAs are built and tested in accordance with the Contractor's product assurance requirements and standards as documented in **DRD CEV-D-004**, *FTA Engineering Design Data Book*.
- i) The Contractor shall document the as-built FTAs per **DRD CEV-D-004**, *FTA Engineering Design Data Book*.
- j) The Contractor shall develop and deliver reports in **DRD CEV-D-005**, *FTA Validation and Verification Data Book*, documenting the FTA validation and verification effort.
- k) The Contractor shall support NASA-provided parachute and pyrotechnic initiator integration into the FTA.
- l) The Contractor shall complete the DD250 for each FTA and deliver the FTAs to the NASA designated test facility.
- m) The Contractor shall deliver the following:
  - o 3 Abort Flight Test Articles
    - LAS-1: FTA1 Crew Module + DD250; LAS + DD250
    - LAS-2: FTA2 Crew Module + DD250; Service Module + DD250; LAS + DD250
    - LAS-3: FTA2 Crew Module + DD250; Service Module + DD250; LAS + DD250

- 1 Risk Reduction Flight (RRF) Flight Test Article
    - RRF-1: Service Module + DD250; DD250
  - Flight Spares
    - LAS (Qty 1)
  - Flight software (source code, executables, and build procedures)
- n) NASA will provide the following products to the Contractor for execution of the above effort:
- CXP-15000, Crew Exploration Vehicle (CEV) Crew Module Outer Mold Line (OML)
  - CXP-15001, Crew Exploration Vehicle (CEV) Aerodynamic and Aerothermal Databases (for all phases of flight)
  - Parachute system in support of nominal and abort entries
  - Pyrotechnics initiators

### ***Deliverables***

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-D-004: Flight Test Article (FTA) Engineering Design Data Book
- DRD CEV-D-005: Flight Test Article (FTA) Validation and Verification Data Book

## ***10.2 Test Article Ground Support Equipment***

Test Article Ground Support Equipment (GSE) includes the design, production, and delivery of the FTA unique ground support equipment, both hardware and associated software, needed for ground and flight operations during the LAS 1, 2, 3 testing.

Note: Work associated with GSE supporting the CEVs for RRF is covered in Section 9.2, Ground Support Equipment.

- a) The Contractor shall design and produce the FTA GSE required for all phases of FTA production, transportation, integration and checkout, and ground and launch processing.
- b) The Contractor shall design and produce the FTA GSE required for post-test FTA safing and recovery.
- c) The Contractor shall include FTA GSE requirements and design in **DRD CEV-D-006, FTA GSE Design Data Book**.
- d) The Contractor shall complete the DD250 for the FTA GSE and deliver the FTA GSE to the NASA- designated test facility.
- e) The Contractor shall operate, maintain and update the FTA GSE for the duration of the flight test activity.
- f) The Contractor shall provide procedures for the FTA GSE.
- g) The Contractor shall provide training for the use of FTA GSE.
- h) The Contractor shall use a ground command, telemetry, and display system that is compatible with the host range. Use of data converters is unacceptable.
- i) The Contractor shall develop a common ground telemetry and data network that allows for software updates via the network. Sites include the Contractor's home site, the host range, JSC, MSFC, and KSC.

***Deliverables***

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-D-006: Flight Test Article (FTA) Ground Support Equipment (GSE) Design Data Book

***10.3 Flight Test Support (IDIQ)***

Flight Test Support includes the Contractor support for the flight test activities.

Note: Flight Test Support for RRF is covered in sections 7 and 9

- a) The Contractor shall provide engineering and technician support for the FTA integration with the ATB.
- b) The Contractor shall provide initial FTA operations training to ten NASA test team individuals.
- c) The Contractor shall provide support for test planning.
- d) The Contractor shall provide support for the test execution.
- e) The Contractor shall provide support for the Post Flight Test Report.
- f) The Contractor shall provide data to NASA for range safety in accordance with Section 7.4, Range Safety, and **DRD CEV-O-007**, *Range Safety Requirements Documents*.

## **ATTACHMENT J-2**

### **DATA PROCUREMENT DOCUMENT**

**-Refer to Volume VII, Part 2 of 2-**

## **ATTACHMENT J-3**

### **APPLICABLE, GUIDANCE, AND INFORMATIONAL DOCUMENTS LIST**



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**1.0 APPLICABLE DOCUMENTS**

In addition to the regulations and procedures identified elsewhere in this contract, the Contractor shall comply with the following regulations and procedures to the extent that they are employed in the Statement of Work (SOW) or Data Requirements Documents (DRDs). Applicable document versions that are in effect at CFI release constitute requirements for this contract. Any applicable and reference documents embedded in the applicable and guidance documents listed in this attachment shall not be applicable unless overtly specified as applicable in the SOW or DRDs.

After contract award, the Contractor may request use of alternate applicable documents instead of the ones specified in this list, provided the change is in the best interests of the Government. NASA approval is required for a change in applicable documents after review of the contractor's rationale. A request for a change in applicable documents will be documented in a contract letter. NASA approval or disapproval will also be documented in a contract letter. Since NASA cannot fully define all engineering and workmanship standards based on program and requirement maturity at this time, the contractor shall define recommended additional standards to apply to Level 3 specifications. The contractor shall identify these additional standards to NASA for approval via contract letter and make these standards available to NASA for review. NASA approval or disapproval will also be documented in a contract letter.

Items listed in the Applicable, Guidance, and Informational Documents will contain some items that have been determined as export controlled documents. These documents are so marked and anyone with access to the documents must comply with the export control law. This includes both control and disclosure of any said documents. Other documents and data listed may not contain any restrictions, however before the release of any information or data the Contractor shall make a determination as to the applicability of U.S. export control laws and regulations.

ID	APPLICABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
<b>450-SNUG</b>	Space Network Users' Guide	CEV-T-058	6.2.1.3
<b>AFJMAN 24-204</b>	Preparing Hazardous Materials for Military Air Shipments		6.2.10
<b>AFSPCMAN 91-710</b>	Range Safety User Requirements Manual	CEV-O-007	3.2, 7.4
<b>AIAA-S-080</b>	AIAA Standard for Space Systems - Metallic Pressure Vessels, Pressurized Structures, and Pressure Components	CEV-T-071	6.1
<b>AIAA-S-081</b>	AIAA Standard for Space Systems - Composite Overwrapped Pressure Vessels	CEV-T-071	6.1
<b>ANSI/EIA-748-98</b>	Earned Value Management Systems	CEV-B-003	1.2.5
<b>ASME Y14.100</b>	Engineering Drawing Practices	CEV-T-004	
<b>ASME Y14.24</b>	Types and Applications Of Engineering Drawings	CEV-T-004	
<b>ASME Y14.34M</b>	Associated Lists	CEV-T-004	
<b>ASME Y14.35M</b>	Engineering Drawings and Associated Documents	CEV-T-004	
<b>CXP-00002</b>	Constellation Design Reference Missions (DRM)	CEV-O-001	1.1
<b>CXP-00003</b>	Constellation Architecture Common Glossary and Acronym List	CEV-M-001	1.1
<b>CXP-00004</b>	Constellation Operations Concept Document	CEV-O-001	
<b>CXP-00101</b>	Constellation Command, Control, Communication, and Information (C3I) Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)	CEV-T-026, CEV-T-047, CEV-T-058	2.3, 6.2.1, 6.2.1.3
<b>CXP-00102</b>	Constellation Design Specification for Natural Environments (DSNE) (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)	CEV-T-044, CEV-T-045	2.1.9.4, 6.1.5.4, 6.1.5.5
<b>CXP-01000</b>	Constellation Human System Integration Requirements (HSIR) (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)		2.1.8, 6.2, 7.1

## Crew Exploration Vehicle - (CEV)

ID	APPLICABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
<b>CXP-01000, Section 3.7</b>	Constellation Human System Integration Requirements (HSIR), Section 3.7	CEV-T-045	6.1.5.5
<b>CXP-01001</b>	Crew Exploration Vehicle (CEV) to Crew Launch Vehicle (CLV) IRD		2.3
<b>CXP-01002</b>	Crew Exploration Vehicle (CEV) to Ground Operations IRD		2.3
<b>CXP-01003</b>	Crew Exploration Vehicle (CEV) to Mission Control IRD		2.3
<b>CXP-01005</b>	Crew Exploration Vehicle (CEV) to Earth Departure Stage (EDS) IRD		2.3
<b>CXP-01006</b>	Crew Exploration Vehicle (CEV) to Portable Equipment IRD		2.3
<b>CXP-01007</b>	International Space Station (ISS) to Crew Exploration Vehicle (CEV) IRD		2.3
<b>CXP-01008</b>	Low Impact Docking System (LIDS) Interface Definition Document (IDD)		2.3
<b>CXP-01009</b>	Suits, EVA and Survival Crew Equipment to CEV IRD		2.3
<b>CXP-01010</b>	Crew Exploration Vehicle (CEV) to Lunar Surface Access Module (LSAM) IRD		2.3
<b>CXP-01013</b>	Androgynous Peripheral Assembly System (APAS) Interface Definition Document (IDD)		2.3
<b>CXP-02005</b>	Constellation Master Verification Plan	CEV-T-015, CEV-T-016	2.1.7, 2.2.1
<b>CXP-02006</b>	Constellation Program Quality Document (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)	CEV-S-001, CEV-S-014	3.4
<b>CXP-02007</b>	Constellation Nomenclature Plan		1.1.4, 1.1.5, 2.1.6, 6.2.1.4
<b>CXP-02010</b>	Constellation Environmental Qualification and Acceptance Testing Requirements (CEQATR) Document		2.1.7
<b>CXP-02012</b>	Methodology For Conduct of Project Constellation Hazard Analyses	CEV-S-003, CEV-S-005, CEV-S-011, CEV-S-013	3.1, 9.2
<b>CXP-02016</b>	NEXIOM Standard for Data Deliverables	CEV-T-001, CEV-T-002	2.1.2

## Crew Exploration Vehicle - (CEV)

ID	APPLICABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
<b>CXP-02017</b>	NEXIOM Standard for Tool, Model and Simulation Deliverables	CEV-T-001, CEV-T-002	2.1.2
<b>CXP-02018</b>	Modeling and Simulation (M&S) Verification and Validation (V&V) Process Plan and Specification	CEV-T-001, CEV-T-002	2.1.2
<b>CXP-02019</b>	Constellation Program Requirements for Preparation of Hardware FMEA/CIL	CEV-S-009, CEV-S-011	
<b>CXP-05000</b>	Constellation Program Natural Environment Definition for Design (NEDD)	CEV-T-044, CEV-T-045	2.1.9.4, 6.1.5.4, 6.1.5.5
<b>CXP-10001</b>	Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD)	CEV-M-001, CEV-M-002, CEV-O-001, CEV-S-009, CEV-T-031, CEV-T-034	1.1, 2.3, 3, 6, 9.2
<b>CXP-10002</b>	CEV Crew Cabin/Cockpit Layout Design Requirements and Standard		6.1.3, 6.2.1.4
<b>CXP-12000</b>	NASA CEV Project Management Plan (PM-0001)	CEV-M-005	1.1.6, 2.1.1, 6
<b>CXP-15000</b>	Crew Exploration Vehicle (CEV) Crew Module Outer Mold Line (OML)		10.1.2, 6, 6.1.2, 6.1.5.1
<b>CXP-15001</b>	Crew Exploration Vehicle (CEV) Aerodynamic and Aerothermal Databases		10.1.2, 6, 6.1.5.1
<b>CXP-15002</b>	Crew Exploration Vehicle (CEV)/Crew Launch Vehicle (CLV) Loads Requirements Data Book		2.1.9.4, 2.2.1, 6.2.6
<b>CXP-15003</b>	CEV Display Format Standards		6.1.3
<b>FED-STD-H28/20</b>	Screw - Thread Standards for Federal Services Revision A or Later Inspection Section 20 Methods for Acceptability of UN, UNR, UNJ, M, and MJ Screw Threads		6.2.10
<b>FIPS 140-2</b>	Security Requirements for Cryptographic Module		6.2.1.3
<b>FIPS-197</b>	Advanced Encryption Standard		6.2.1.3
<b>ICD-GPS-200</b>	Navstar GPS Space Segment/Navigation User Interfaces	CEV-T-058	6.2.1.3

ID	APPLICABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
IEEE 1516 -2000	IEEE Standard for Modeling and Simulation (M&S) High Level Architecture (HLA) – Framework and Rules	CEV-T-001	2.1.2
IEEE 1516.1-2000	IEEE Standard for Modeling and Simulation (M&S) High Level Architecture (HLA) .Federate Interface Specification	CEV-T-001	2.1.2
IEEE 1516.2-2000	IEEE Standard for Modeling and Simulation (M&S) High Level Architecture (HLA). Object Model Template (OMT) Specification	CEV-T-001	2.1.2
IEEE 802.16e	IEEE Standard for Local and Metropolitan Area Networks, Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems - Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands		6.2.1.3
IEEE1516.3-2000	IEEE Recommended Practice for High Level Architecture (HLA) Federation Development and Execution Process (FEDEP)	CEV-T-001	2.1.2
IPC-2221	Generic Standard on Printed Board Design	CEV-S-015, CEV-S-017	3.4
IPC-2222	Sectional Design Standard for Rigid Organic Printed Boards	CEV-S-015, CEV-S-017	3.4
IPC-6011, Performance Class 3	Generic Performance Specification For Printed Wiring Boards	CEV-S-015, CEV-S-017	
IPC-6012	Qualification and Performance Specification for Rigid Printed Boards	CEV-S-015, CEV-S-017	3.4
IPC-A-610	Acceptability of Electronic Assemblies, Performance Class 3		2.1.9.1
IPC/EIA J-STD-001	Performance Class 3 with Space Addendum (Requirements for Soldered Electrical and Electronic Assemblies)		2.1.9.1, 3.4
JPR 8080.5	JSC Design and Procedural Standards (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List) (exclusive of government shalls)		6.2
JPR 8080.5, E-14	JSC Design and Procedural Standard, E-14, Electrical Wire Harness Acceptance Testing		2.1.9.1
JPR 8080.5, E-22	JSC Design and Procedural Standards, Section E22, Ionizing Radiation Effects	CEV-T-027	2.1.9.3

ID	APPLICABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
JPR 8080.5, E-24	JSC Design and Procedural Standard, E-24, Electrical Wire and Cable Acceptance Test		2.1.9.1
JPR 8080.5, E-6	JSC Design and Procedural Standard E-6, Corona Suppression	CEV-T-024	2.1.9.1
JPR 8080.5, E-7	JSC Design and Procedural Standards, Section E-7, Electrical Components – Restrictions on Use	CEV-T-027	2.1.9.3
JPR 8080.5, M/S-11	JSC Design and Procedural Standards, Section M/S-11, Meteoroid and Orbital Debris Protection Levels for Structures	CEV-T-044	6.1.5.4
JSC 20431	NASA JSC Neutron Radiography Specification		6.2.10
JSC 20584	Spacecraft Maximum Allowable Concentrations for Airborne Contaminants	CEV-T-073, CEV-T-074	6.2.9
JSC 49774A	Standard Manned Spacecraft Requirements for Materials and Processes (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)	CEV-T-019, CEV-T-020, CEV-T-021, CEV-T-022, CEV-T-023	2.1.9.1
JSC 62550	Structural Design and Verification Criteria for Glass, Ceramics and Windows in Human Space Flight Applications		6.2.6
JSC 62809	NASA Human Rated Spacecraft Pyrotechnic Specification	CEV-T-075	6.2.10
JSC/SKD 26100132	Performance Specification for NSTS Use of Percussion Primers		6.2.10
KSC-HB-GP60-3	ASRS Handbook	CEV-O-003	7.2
MIL-DTL-398	RDX (Cyclotrimethylenetrinitramine)		6.2.10
MIL-DTL-45444	HMX (Cyclotetramethylenetetranitramine)		6.2.10
MIL-HDBK-6870A	Inspection Program Requirements Nondestructive for Aircraft and Missile Materials and Parts	CEV-T-023	
MIL-L-3055	Type I Lead Azide		6.2.10
MIL-L-46225	Lead Azide RD-1333		6.2.10
MIL-P-20444C	Primer, Percussion, M42 Parts for and Loading, Assembling and Packaging		6.2.10

ID	APPLICABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
MIL-P-387	Pentaerythrite Tetranitrate (PETN)		6.2.10
MIL-STD-1576	Electro Explosive Subsystem Safety Requirements and Test Methods for Space Systems	CEV-T-025	
MIL-STD-286	Military Standard Propellants, Solid: Sampling Examination and Testing; Method 802.1		6.2.10
MIL-STD-461E	Requirements for the Control of Electromagnetic Interference (EMI) Characteristics of Subsystems and Equipment	CEV-T-025	2.1.9.2
MIL-STD-464A	Electromagnetic Environmental Effects Requirements for Systems	CEV-T-025	2.1.9.2
ML0303-0014	Electrical Wire Harnesses and Coaxial Cables, Installation Requirements for Electromagnetic Compatibility	CEV-T-025	2.1.9.2
MSFC-STD-3029	Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments	CEV-T-020	
NAS 412	Foreign Object Damage/ Foreign Object Debris (FOD) Prevention	CEV-T-021	
NASA TP-2003-210788	Meteoroid/Debris Shielding, 2003, Section 2 for describing the MMOD risk assessment process using Bumper code	CEV-T-044	6.1.5.4
NASA-STD-4003	Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment	CEV-T-025	2.1.9.2
NASA-STD-5001	Structural Design and Test Factors of Safety for Space Flight Hardware	CEV-T-015	6.2.6
NASA-STD-5002	Loads Analyses of Spacecraft and Payloads	CEV-T-015	6.2.6
NASA-STD-5005B	NASA Standard for Ground Support Equipment (and associated Applicable Document Children as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)	CEV-D-006, CEV-O-008	9.2
NASA-STD-5007	General Fracture Control Requirements for Manned Space Flight Systems	CEV-T-023, CEV-T-069, CEV-T-070	6.2.6
NASA-STD-5009	Nondestructive Evaluation Requirements for Fracture Control Programs	CEV-T-023	



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ID	APPLICABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
NASA-STD-5017	Design and Development Requirements for Mechanisms, Sections 1-4	CEV-T-061	6.2.3
NASA-STD-8719.9	NASA Standard for Lifting Devices and Equipment	CEV-S-005	
NASA-STD-8739.8	NASA Software Assurance Standard (Chapter 6 and 7)	CEV-S-001, CEV-S-018	2.1.4, 3.5
National Council on Radiation Protection and Measurements Report No. 132	National Council on Radiation Protection and Measurements Report No. 132: Radiation Protection Guidance for Activities in Low-Earth Orbit	CEV-T-045	6.1.5.5
National Council on Radiation Protection and Measurements Report No. TBD	Radiation Protection and Science Goals for Lunar Missions (to be published in 2006)	CEV-T-045	6.1.5.5
NPD 9501.1G	NASA Contractor Financial Management Reporting System	CEV-B-001	
NPD 9501.3A	Earned Value Management	CEV-B-003	
NPR 6000.1G	Requirements for Packaging, Handling, and Transportation of Aeronautical and Space Systems, Equipment, and Associated Components	CEV-T-011	
NPR 7150.2	NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)	CEV-T-005, CEV-T-006, CEV-T-029, CEV-T-048, CEV-T-049, CEV-T-050, CEV-T-051, CEV-T-052, CEV-T-053, CEV-T-054, CEV-T-055, CEV-T-056, CEV-T-057	1.5, 10.1.2, 2.1.4
NPR 8580.1	Implementing the National Environmental Policy Act and Executive Order 12114		3.2
NPR 8621.1A	NASA Procedural Requirements for Mishap Reporting, Investigating, and Recordkeeping		3.2
NPR 8715.5	Range Safety Program	CEV-O-007	3.2, 7.4

ID	APPLICABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
<b>NPR 9501.2D</b>	NASA Contractor Financial Management Reporting	CEV-B-001, CEV-M-002	
<b>NPR 9501.3</b>	Earned Value Management Implementation Plan on NASA Contracts	CEV-B-003	
<b>NSS-1704.14</b>	Guidelines and Assessment Procedures for Limiting Orbital Debris	CEV-S-007	
<b>NSTS 08307</b>	Space Shuttle Criteria for Preloaded Bolts		6.2.6
<b>NTIA Manual</b>	National Telecommunications and Information Administration (NTIA) Manual of Regulations & Procedures for Federal Radio Frequency Management (May 2003 Edition, May 2005 Revisions) Chapter 10	CEV-T-026	2.1.9.2, 6.2.1.3
<b>OSHA Standards 29 CFR</b>	Supplementary Standards 1960.18	CEV-S-005, CEV-T-045	6.1.5.5
<b>Range Commanders Council - Range Safety Group - Standard 321-02</b>	COMMON RISK CRITERIA FOR NATIONAL TEST RANGES	CEV-O-007	
<b>S0300-BT-PRO-010</b>	Government-Industry Data Exchange Program (GIDEP) Operations Manual	CEV-S-001, CEV-S-012	
<b>WS 5003F</b>	Material Specification for HNS Explosive		6.2.10

**1.1 APPLICABLE DOCUMENT CHILDREN**

For the following applicable or guidance documents, their embedded applicable children documents identified in the Approved Children Table are also applicable or to be used as guidance depending on the parent document's category or as otherwise indicated:

- JSC 49774A, Standard Manned Spacecraft Requirements for Materials and Processes
- NASA-STD-5005B, NASA Standard for Ground Support Equipment
- MSFC-SPEC-164B, Specification for Cleanliness of Components for Use in Oxygen, Fuel and Pneumatic Systems
- CXP-00101, Constellation C3I Interoperability Standard
- CXP-00102, Constellation Program Design Specification for Natural Environments (DSNE)  
[The DSNE invokes portions of CP-DOC-00004, Constellation Program Natural Environment Definition for Design (NEDD) where other children documents, models and datasets are then subsequently invoked. These NEDD children documents, models and datasets are listed as applicable children to the DSNE.]
- CXP-20006, Constellation Program Quality Document
- JPR 8080.5, JSC Design and Procedural Standards
- CXP-01000, Constellation Human Systems Integration Requirements (HSIR)
- CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element
- CXP-01001, Crew Exploration Vehicle (CEV) to Crew Launch Vehicle (CLV) IRD

ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
PARENT APPLICABLE DOCUMENT	PARENT APPLICABLE DOCUMENT: JSC 49774A, Standard Manned Spacecraft Requirements for Materials and Processes	CEV-T-015, CEV-T-017, CEV-T-018, CEV-T-019, CEV-T-020	2.1.9.1
	<i>JSC 49774A Approved Children</i>		
ASTM-E595-93 (re-approved 2003)	Standard Test Methods for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing In a Vacuum Environment		
AWS C3.3-2002	Design, Manufacture and Examination of Critical Brazed Components, Recommended Practices For The,		
AWS C3.4-1999	Specification for Torch Brazing		
AWS C3.5-1999	Specification for Induction Brazing		
AWS C3.6-1999	Specification for Furnace Brazing		
AWS C3.7-1999	Specification for Aluminum Brazing		
DOT/FAA/AR-MMPDS-01	Metallic Materials Properties Development and Standardization (MMPDS)		
JSC 20584	Spacecraft Maximum Allowable Concentrations for Airborne Contaminants		
Materials and Processes Technical Information System (MAPTIS)	Materials Selection List for Space Hardware Systems		
MIL-HDBK-17/1F	Composite Materials Handbook, Volume 1. Polymer Matrix Composites Guidelines for Characterization of Structural Materials		
MIL-HDBK-17/2F	Composite Materials Handbook, Volume 2. Polymer Matrix Composites Materials Properties		
MIL-HDBK-17/3F	Composite Materials Handbook, Volume 3. Polymer Matrix Composites Materials Usage, Design, and Analysis		
MIL-HDBK-17/4A	Composite Materials Handbook, Volume 4. Metal Matrix Composites		
MIL-HDBK-17/5	Composite Materials Handbook, Volume 5. Ceramic Matrix Composites		
MIL-HDBK-454A (2000)	General Guidelines for Electronic Equipment		

ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
<b>MIL-STD-810F</b> (For Guidance only)	DOD Test Method Standard for Environmental Engineering Considerations and Laboratory Tests, Section 5 and Part 2		
<b>MIL-STD-889B Chg 3 (1993)</b>	Dissimilar Metals		
<b>MSFC-SPEC-250A (1977)</b>	Protective Finishes for Space Vehicle Structures and Associated Flight Equipment, General Specification For		
<b>MSFC-SPEC-445A (1990)</b>	Adhesive Bonding, Process and Inspection, Requirements for		
<b>MSFC-STD-557 (1980)</b>	Threaded Fasteners, 6Al-4V Titanium Alloy, Usage Criteria for Spacecraft Applications		
<b>MSFC-STD-2594C (2002)</b>	MSFC Fastener Management and Control Practices		
<b>MSFC-STD-3029</b>	Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments		
<b>NAS 412 (1997)</b>	Foreign Object Damage/Foreign Object Debris (FOD) Prevention		
<b>NASA-STD-5006 (1999)</b>	General Fusion Welding Requirements for Aerospace Materials Used in Flight Hardware		
<b>MSFC-STD-1249</b>	Standard NDE Guidelines and Requirements for Fracture Control Programs		
<b>Replaced by NASA-STD-5009</b>	Replaced by: Nondestructive Evaluation Requirements for Fracture Control Programs		
<b>NASA-STD-6001 (1998)</b>	Flammability, Odor, Offgassing and Compatibility Requirements and Test Procedures For Materials In Environments That Support Combustion		
<b>NASA-TM-104823 (1996)</b>	Guide for Oxygen Hazards Analyses on Components and Systems		
<b>NASA-TM-86556 (1985)</b>	Lubrication Handbook For the Space Industry, Part A: Solid Lubricants, Part B: Liquid Lubricants		
<b>SAE-AMS 2175 (2003)</b>	Castings, Classification and Inspection Of		
<b>SAE-AMS 2488D (2000)</b>	Anodic Treatment - Titanium & Titanium Alloys, Solution pH 13 or Higher		
<b>SAE-AMS 2491D (2003)</b>	Surface Treatment of Polytetrafluoroethylene, Preparation for Bonding		
<b>SAE-AMS 2759/9B (2003)</b>	Hydrogen Embrittlement Relief (Baking) of Steel Parts		
<b>SAE-AMS 2759C (2000)</b>	Heat Treatment of Steel Parts, General Requirements		
<b>SAE-AMS 2770G (2003)</b>	Heat Treatment of Wrought Aluminum Alloy Parts		

ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
SAE-AMS 2772C (2002)	Heat Treatment of Aluminum Alloy Raw Materials		
SAE-AMS 2774 (1995, Reaffirmed 2001)	Heat Treatment, Wrought Nickel Alloy and Cobalt Alloy Parts		
SAE-AMS-H-6875A (1998)	Heat Treatment Of Steel Raw Materials		
SAE-AMS-H-81200A (2003)	Heat Treatment of Titanium and Titanium Alloys		
SAE-AMS-STD-401 (1999)	Sandwich Constructions and Core Materials; General Test Methods		
PARENT APPLICABLE DOCUMENT	PARENT APPLICABLE DOCUMENT: NASA-STD-5005B, NASA Standard for Ground Support Equipment	CEV-D-006, CEV-O- 005	9.2
	<i>NASA-STD-5005B Approved Children</i>		
ADM-1	Aluminum Design Manual		
AISC 316-89	Manual of Steel Construction – Vol. 1 (Reference 316-1989) Allowable Stress Design		
AISC 325-01	LFRD Manual of Steel Construction – Third Edition		
AISI-SG-673	Cold-Formed Steel Design Manual		
AMS H-6875	Heat Treatment of Steel Raw Materials		
AMS2770	Heat Treatment of Wrought Aluminum Alloy Parts		
AMS2771	Heat Treatment of Aluminum Alloy Casting		
AMS2772	Heat Treatment of Wrought Aluminum Alloy Raw Materials		
AMS-H-81200	Heat Treatment of Titanium and Titanium Alloys		
ARP 1247	General Requirements for Aerospace Ground Support Equipment, Motorized and Nonmotorized		
AS 1097	Seal Ring 37-Degree Flared Tube Fitting End		
AS 8090	Mobility, Towed Aerospace Ground Equipment, General Requirements for		
ASME A13.1	Scheme for the Identification of Piping Systems		
ASME B30.1	Jacks – Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings		

ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
ASME B31.3	Process Piping		
ASME Vessel Code, Section IX Procedures	ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications		
ASME Vessel Code, Section VIII, Divisions 1, 2, and 3	ASME Boiler and Pressure Vessel Code, Section VIII: Pressure Vessels Divisions 1, 2, and 3		
ASTM A269	Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service		
ASTM A325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength		
ASTM A36	Standard Specification for Carbon Structural Steel		
ASTM A490	Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength		
ASTM A514/A514M	Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding		
ASTM A517/A517M	Standard Specification for Pressure Vessel Plates, Alloy Steel, High-Strength, Quenched and Tempered		
ASTM MANUAL 36	Safe Use of Oxygen and Oxygen Systems: Guidelines for Oxygen System Design, Materials Selection, Operations, Storage, and Transportation		
AWS D1.2/D1.2M	Structural Welding Code – Aluminum		
AWS D1.3	Structural Welding Code – Sheet Steel		
AWS D1.6	Structural Welding Code – Stainless Steel		
AWS D1/D1.1M	Steel - Structural Welding Code - Standard for		
CGA C-7	Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers		
EIA 310	Cabinets, Racks, Panels, and Associated Equipment		
FED-STD-595	Colors Used in Government Procurement		
IEEE/ASTM SI10	American National Standard for Use of the International System of Units (SI): The Modern Metric System		
ISO 15389	Space systems – Flight-to-ground umbilicals		

ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
KSC-C-123	Surface Cleanliness of Fluid Systems, Specification for		
KSC-E-165	Electrical Ground Support Equipment, Fabrication, Specification for		
KSC-SPEC-E-0029	Compound, Potting and Molding, Elastomeric, Specification for		
KSC-SPEC-E-0031	Cables, Electrical, General Specification for		
KSC-SPEC-Z-0008	Fabrication and Installation of Flared Tube Assemblies and Installation of Fittings and Fitting Assemblies, Specification for		
KSC-SPEC-Z-0009	Lubrication, Thread, Corrosion-Resistant Steel and Aluminum Alloy Tube Fittings, Specification for		
KSC-STD-E-0004	Pneumatic and Hydraulic Mechanical Components, Electrical Design, Standard for (ITAR Controlled)		
KSC-STD-Z-0005	Pneumatic Ground-Support Equipment, Design of, Standard for (ITAR Controlled)		
KSC-STD-Z-0006	Hypergolic Propellants Ground Support Equipment, Design of, Standard for (ITAR Controlled)		
KSC-STD-Z-0008	Design of Ground Life Support Systems and Equipment, Standard for		
MIL-C-22992	Connectors, Plugs and Receptacles, Electrical, Waterproof, Quick Disconnect, Heavy Duty Type, General Specification for		
MIL-DTL-16878	Wire, Electrical, Insulated, General Specification for		
MIL-DTL-38999	Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for		
MIL-DTL-5015	Connectors, Electrical, Circular Threaded, AN Type, General Specification for		
MIL-HDBK-149	Rubber		
MIL-HDBK-17/1	Composite Materials Handbook Volume 1: Polymer Matrix Components Guidelines for Characterization of Structural Materials		
MIL-HDBK-454	General Guidelines for Electronic Equipment		
MIL-HDBK-5961	List of Standard Semiconductor Devices		
MIL-HDBK-5H	Metallic Materials and Elements for Aerospace Vehicle Structures		



ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
MIL-HDBK-6870A	Inspection Program Requirements Nondestructive for Aircraft and Missile Materials and Parts		
MIL-HDBK-700	Plastics		
MIL-M-8609	Motors, Direct-Current, 28 Volt System, Aircraft (Inactive for new design)		
MIL-PRF-39012	Connectors, Coaxial, Radio Frequency, General Specification for		
MIL-STD-1472	Department of Defense Design Criteria Standard, Human Engineering		
MIL-STD-1576	Electroexplosive Subsystem Safety Requirements and Test Methods for Space Systems		
MIL-STD-171	Finishing of Metal and Wood Surfaces		
MIL-STD-461E	Requirements for the Control of Electromagnetic Interference (EMI) Characteristics of Subsystems and Equipment		
MIL-STD-889	Dissimilar Metals		
MIL-W-22759	Wire, Electrical, Fluoropolymer-Insulated Copper or Copper Alloy		
MIL-W-5086	Wire, Electric, Polyvinyl Chloride Insulated, Copper or Copper Alloy		
MSFC-STD-156	Riveting, Fabrication and Inspection, Standard for		
MSFC-SPEC-164B (For Guidance only)	Specification for Cleanliness of Components for Use in Oxygen, Fuel and Pneumatic Systems, inclusive of Specifications in Section 2.1.1		
MSFC-SPEC-250A (1977)	Protective Finishes for Space Vehicle Structures and Associated Flight Equipment, General Specification For		
MSFC-STD-486	Standard, Threaded Fasteners, Torque Limits for		
MSFC-STD-3029	Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments		
NASA-HDBK-1001	Terrestrial Environment (Climatic) Criteria Handbook for Use in Aerospace Vehicle Development		
NASA-SPEC-5004	Welding of Aerospace Ground Support Equipment and Related Nonconventional Facilities		
NASA-STD-5008	Protective Coating of Carbon Steel, Stainless Steel and Aluminum on Launch Structures, Facilities and Ground Support Equipment		

ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
NASA-STD-6001	Flammability, Odor, Offgassing & Compatibility Requirements & Test Procedures for Materials in Environments That Support Combustion		
NASA-STD-8719.9	Standard for Lifting Devices and Equipment		
NBS HDBK-105-1	Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures		
NEMA-ICS2	Industrial Control and Systems: Controllers, Contractors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC		
NEMA-MG1	Information Guide for General Purpose Industrial AC Small and Medium Squirrel-Cage Induction Motor Standards		
NFPA 496	Purged and Pressurized Enclosures for Electrical Equipment		
NFPA 50	Bulk Oxygen Systems at Consumer Sites		
NFPA 50B	Liquified Hydrogen Systems at Consumer Sites		
NFPA 70	National Electrical Code		
NFPA 780	Installation of Lightning Protection Systems		
No number/ASHRAE Handbooks	ASHRAE Handbooks		
No number/Brazing Manual	Brazing Manual		
No number/Handbook for Spring Design	Handbook for Spring Design		
No number/Soldering Manual	Soldering Manual		
NPD 8010.2	Use of Metric System of Measurement in NASA Programs		
NPG 8715.3	NASA Safety Manual		
NSS 1740.16	Safety Standard for Hydrogen and Hydrogen Systems Guidelines for Hydrogen System Design, Materials Selection, Operations, Storage and Transportation		
Replaced by ANSI/AIAA G-095-2004	Replaced by: ANSI/AIAA G-095-2004: Guide to Safety of Hydrogen and Hydrogen Systems		
T9074-BD-G1B-010/300	Base Materials For Critical Applications: Requirements For Low Alloy Steel Plate, Forgings, Castings, Shapes, Bars, And Heads Of HY-80/100/130 And HSLA-80/100		

ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
<b>PARENT GUIDANCE DOCUMENT</b>	<b>PARENT GUIDANCE DOCUMENT: MSFC-SPEC-164B, Specification for Cleanliness of Components for Use in Oxygen, Fuel and Pneumatic Systems</b>		6.2.9
	<b><i>MSFC-SPEC-164B Approved Children</i></b>		
<b>BB-N-411</b> <b>Replaced by A-A-59503</b>	Type 1, Class 1, Nitrogen Replaced by: Commercial Item Description Nitrogen, Technical		
<b>KSC/MTB-402</b>	Physical and Chemical Test Results of Plastic Films		
<b>MIL-P-27401D</b>	Performance Specification Propellant Pressurizing Agent, Nitrogen: Type 1, Grade A - Nitrogen		
<b>MIL-T-27602</b> <b>Replaced by MIL-C-81302D</b>	Trichloroethylene Replaced by: Military Specification Cleaning Compound, Solvent, Trichlorotrifluoroethane: Type 1 Trichlorotrifluoroethane (CFC 113)		
<b>MIL-T-81533</b>	Military Specification 1,1,1-Trichloroethane (Methyl Chloroform) Inhibited, Vapor Degreasing		
<b>NHB-8060.1 B</b>	Flammability, Odor, And Offgassing Requirements And Test Procedures For Materials in Environments That Support Combustion		
<b>NHB-8060.1 C</b>	Flammability, Odor, Offgassing and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion		
<b>PPP-T-60</b> <b>Replaced by ASTM STD Spec D 5486</b>	Tape, Packaging, Waterproof Replaced by: Standard Specification for Pressure-Sensitive Tape for Packaging, Box Closure and Sealing		
<b>PARENT APPLICABLE DOCUMENT</b>	<b>PARENT APPLICABLE DOCUMENT: CXP-00101, Constellation C3I Interoperability Standard</b>		6.2.1
	<b><i>CXP-00101, Constellation C3I Interoperability Standard Approved Children</i></b>		
<b>RFC-1918</b>	Address Allocation for Private Internets		
<b>RFC-3171</b>	Guidelines for IPv4 Multicast Address Assignments		
<b>RFC-2131</b>	Dynamic Host Configuration Protocol (DHCP)		
<b>RFC-3927</b>	Dynamic Configuration of IPv4 Link-Local Addresses		
<b>RFC-826</b>	Ethernet Address Resolution Protocol: Or converting network protocol addresses to 48.bit Ethernet address for transmission on Ethernet hardware		

ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
RFC-1812	Requirements for IP Version 4 Routers		
RFC-1122	Requirements for Internet Hosts - Communications Layers		
RFC-1771	Border Gateway Protocol 4 (BGP-4)		
RFC-2453	Routing Information Protocol (RIP), Version 2		
RFC-2328	Open Shortest Path First (OSPF), Version 2		
RFC-793	Transmission Control Protocol (TCP)		
CCSDS 714.0-B-1	Space Communications Protocol Specification (SCPS)--Transport Protocol (TP) and CCSDS 714.0-B-1 Cor. 1, Technical Corrigendum 1 to CCSDS 714.0-B-1		
RFC-768	User Datagram Protocol (UDP)		
RFC-3550	A Transport Protocol for Real-Time Applications		
RFC-3984	RTP Payload Format for H.264 Video		
RFC-2246	A Transport Layer Security (TLS) Protocol, Version 1.0		
CCSDS 727.0-B-3	CCSDS File Delivery Protocol (CFDP)		
STD-0005	Internet Protocol (IP) Standard 5		
RFC-791	Internet Protocol		
RFC-792	Internet Control Message Protocol		
RFC-919	Broadcasting Internet Datagrams		
RFC-922	Broadcasting Internet Datagrams in the Presence of Subnets		
RFC-950	Internet Standard Subnetting Procedure		
RFC-1112	Host Extensions for IP Multicasting		
RFC-3246	An Expedited Forwarding PHB (Per-Hop Behavior)		
RFC-2474	Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers		

ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
<b>RFC-2205 Version 1</b>	Resource ReSerVation Protocol (RSVP) - Version 1 Functional Specification		
<b>H.323</b>	Packet-based Multimedia Communications Systems; Section 6.2 Only		
<b>H.225</b>	Call Signaling Protocols and Media Stream Packetization for Packet-based Multimedia Communication Systems.		
<b>H.245</b>	Control Protocol for Multimedia Communication.		
<b>G.711</b>	Pulse Code Modulation (PCM) of Voice Frequencies		
<b>G.722</b>	7 kHz Audio-coding within 64 kbit/s		
<b>G.723.1</b>	Dual Rate Speech Coder for Multimedia Communications Transmitting at 5.3 and 6.3 kbit/s.		
<b>G.728</b>	Coding of Speech at 16 kbit/s Using Low-delay Code Excited Linear Prediction.		
<b>G.729</b>	Coding of Speech at 8 kbit/s Using Conjugate Structure Algebraic-code-excited Linear-prediction (CS-ACELP).		
<b>H.264/AVC</b>	Series H: Audiovisual and Multimedia Systems Infrastructure of audiovisual services – Coding of moving video: Advanced video coding for generic audiovisual services		
<b>IEEE 802.16e</b>	Air Interface for Fixed Broadband Wireless Access Systems		
<b>ITU-T Recommendation T.35 (2000)</b>	Procedure for the Allocation of ITU-T Defined Codes for Nonstandard Facilities		
<b>ISO/IEC 11578:1996</b>	Information technology – Open Systems Interconnection – Remote Procedure Call (RPC) Annex A, Universal Unique Identifier		
<b>ISO/CIE 10527:1991</b>	CIE standard colorimetric observers		
<b>PARENT APPLICABLE DOCUMENT</b>	<b>PARENT APPLICABLE DOCUMENT: CXP-00102, Constellation Program Design Specification for Natural Environments (DSNE)</b>	CEV-T-044, CEV-T-045	2.1.9.4, 6.1.5.4, 6.1.5.5
	<b><i>CXP-00102 Approved Children</i></b>		
<b>CXP-05000</b>	Constellation Program Natural Environment Definition for Design (NEDD)		
<b>EGM 1996</b>	Earth Gravitational Model 1996		
<b>GRAM-99</b>	Global Reference Atmospheric Model, 1999 Version (GRAM-99)		
<b>JWPD</b>	Jimosphere Wind Profile Dataset		

ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
LP100K	Lunar Prospector 100K (LP100K) Gravity Model		
MEM	Meteoroid Engineering Model (MEM)		
ORDEM 2000	Orbital Debris Engineering Model (ORDEM 2000)		
NASA-HDBK-1001	Terrestrial Environment (Climatic) Criteria Handbook for Use in Aerospace Vehicle Development		
RRA	Range Reference Atmosphere (RRA) Model		
RTCA/DO-160D (For guidance only)	Environmental Conditions and Test Procedures for Airborne Equipment (Section 22: Lightning Induced Transient Susceptibility and Section 23: Lightning Direct Effects)		
SAE-ARP-5412 (For guidance only)	Aircraft Lightning Environment		
SAE-ARP-5414 (For guidance only)	Aircraft Lightning Zoning		
PARENT APPLICABLE DOCUMENT	PARENT DOCUMENT: CXP-20006, Constellation Program Quality Document	CEV-S-001, CEV-S-014	3.4
	<i>CXP-20006 Approved Children</i>		
ARP9004	Direct Ship - Recommended Practices for Aerospace Companies		
ARP9009	Aerospace Contract Clauses		
ARP9062	Aerospace Operator Self-Verification Programs		
ARP9090	Requirements for Industry Standard e-Tool		
ARP9134	Supply Chain Risk Management Guidelines		
AS9003	Inspection and Test Quality System		
AS9006	Deliverable Aerospace Software Supplement for AS9100a		
AS9100	Quality Systems - Aerospace - Model for Quality Assurance in Design, Development, Production, Installation and Servicing		
AS9102	Aerospace First Article Inspection Requirement		

ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
AS9103	Variation Management of Key Characteristics		
AS9110	Quality Maintenance Systems - Aerospace - Requirements for Maintenance Organizations		
AS9120	Quality Management Systems - Aerospace Requirements for Stockist Distributors		
AS9131	Quality Systems Non-Conformance Documentation		
PARENT APPLICABLE DOCUMENT	PARENT DOCUMENT: JPR 8080.5, JSC Design and Procedural Standards		6.2
	<i>JPR 8080.5 Approved Children</i>		
AIAA-S-080	AIAA Standard for Space Systems - Metallic Pressure Vessels, Pressurized Structures, and Pressure Components		
AIAA-S-081	AIAA Standard for Space Systems - Composite Overwrapped Pressure Vessels		
ASME Vessel Code, Section VIII, Divisions 1, 2, and 3	ASME Boiler and Pressure Vessel Code, Section VIII: Pressure Vessels Divisions 1, 2, and 3		
ASTM A36	Standard Specification for Carbon Structural Steel		
JSC 49774A	Standard Manned Spacecraft Requirements for Materials and Processes (inclusive of all embedded applicable documents)		
NASA-STD-3000, Volume VIII Replaced by CXP-01000	NASA-STD-3000, Volume VIII, Human Systems Integration Standards (HSIS), CEV Launch Segment (CEV and CEVLV) Replaced by: Constellation Human Systems Integration Requirements (HSIR)		
NASA-STD-5001	Structural Design and Test Factors of Safety for Space Flight Hardware		
NAS 412 (1997)	Foreign Object Damage/Foreign Object Debris (FOD) Prevention		
NSTS 08060 Replaced by JSC 62809	Space Shuttle System Pyrotechnic Specification Replaced by: NASA Human Rated Spacecraft Pyrotechnic Specification		
SAE-ARP-5412 (For guidance only)	Aircraft Lightning Environment		

ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
<b>SAE-ARP-5413</b> (For guidance only)	Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning		
<b>SAE-ARP-5414</b> (For guidance only)	Aircraft Lightning Zoning		
<b>SAE-ARP-5415</b> (For guidance only)	Users Manual for Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning		
<b>SAE-ARP-5577</b> (For guidance only)	Aircraft Lightning Direct Effects Certification		
<b>PARENT APPLICABLE DOCUMENT</b>	<b>PARENT DOCUMENT: CXP-01000, Constellation Human Systems Integration Requirements (HSIR)</b>		2.1.8, 6.2, 7.1
	<b><i>CXP-01000 Approved Children</i></b>		
<b>AGARD-CP-472</b>	Implications of Advanced Escape Technologies for Air and Spacecraft Escape		
<b>CXP-00102</b>	Constellation Program Design Specification for Natural Environments (DSNE)		
<b>JSC 20584</b>	Spacecraft Maximum Allowable Concentrations for Airborne Contaminants		
<b>JSC 63307</b>	Optical Design Requirements for Windows in Human Space Flight Applications		
<b>PARENT APPLICABLE DOCUMENT</b>	<b>PARENT DOCUMENT: CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element</b>		
	<b><i>CXP-10001 Approved Children</i></b>		
<b>450-SNUG</b>	Space Network Users' Guide		
<b>AFSPCMAN 91-710</b>	Range Safety User Requirements Manual		
<b>AIAA-S-080</b>	AIAA Standard for Space Systems - Metallic Pressure Vessels, Pressurized Structures, and Pressure Components		
<b>AIAA-S-081</b>	AIAA Standard for Space Systems - Composite Overwrapped Pressure Vessels		
<b>CXP-00101</b>	Constellation C3I Interoperability Standard (inclusive of all embedded applicable documents)		



ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
<b>CXP-00102</b>	Constellation Program Design Specification for Natural Environments (DSNE)		
<b>CXP-01013</b>	Androgynous Peripheral Assembly System (APAS) Interface Definition Document (IDD)		
<b>CXP-05000</b>	Constellation Program Natural Environment Definition for Design (NEDD)		
<b>FIPS-197</b>	Advanced Encryption Standard (AES)		
<b>IPC-A-610</b>	Acceptability of Electronic Assemblies, Performance Class 3		
<b>JSC 20584</b>	Spacecraft Maximum Allowable Concentrations for Airborne Contaminants		
<b>JSC 49774A</b>	Standard Manned Spacecraft Requirements for Materials and Processes (inclusive of all embedded applicable documents)		
<b>JSC 62550</b>	Structural Design and Verification Criteria for Glass, Ceramics and Windows in Human Space Flight Applications		
<b>JSC 62809A</b>	Human Rated Spacecraft Pyrotechnic Specification		
<b>MIL-STD-1576</b>	Electroexplosive Subsystem Safety Requirements and Test Methods for Space Systems		
<b>NASA-STD-4003</b>	Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment		
<b>NASA-STD-5001</b>	Structural Design and Test Factors of Safety for Spaceflight Hardware		
<b>NASA-STD-5017</b>	Design and Development Requirements for Mechanisms, Sections 1-4		
<b>NPR 2810.1</b>	Security of Information Technology		
<b>NPR 8715.5</b>	Range Safety Program		
<b>NSS-1740.14</b>	Guidelines and Assessment Procedures for Limiting Orbital Debris, Sections 6 and 7 only		
<b>NSTS 08307</b>	Space Shuttle Criteria for Preloaded Bolts		
<b>SAE-ARP-5412</b> (For guidance only)	Aircraft Lightning Environment and Related Test Waveforms		

ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
<b>SAE-ARP-5413</b> (For guidance only)	Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning		
<b>SAE-ARP-5414</b> (For guidance only)	Aircraft Lightning Zoning		
<b>SAE-ARP-5415</b> (For guidance only)	Users Manual for Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning		
<b>SAE-ARP-5416</b> (For guidance only)	Aircraft Lightning Test Methods		
<b>SAE-ARP-5577</b> (For guidance only)	Aircraft Lightning Direct Effects Certification		
<b>PARENT APPLICABLE DOCUMENT</b>	<b>PARENT DOCUMENT: CXP-01001, Crew Exploration Vehicle (CEV) to Crew Launch Vehicle (CLV) IRD</b>		2.3
	<b><i>CXP-01001 Approved Children</i></b>		
<b>SSP 30240</b> (For guidance only)	Space Station Grounding Requirements		
<b>MIL-STD-464A</b>	Electromagnetic Environmental Effects Requirements for Systems		
<b>MIL-STD-461E</b>	Requirements for the Control of Electromagnetic Interference (EMI) Characteristics of Subsystems and Equipment		
<b>ML0303-0014</b>	Electrical Wire Harnesses and Coaxial Cables, Installation Requirements for Electromagnetic Compatibility		
<b>NASA-STD-4003</b>	Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment		
<b>ASTM-E595-93 (re-approved 2003)</b>	Standard Test Methods for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing In a Vacuum Environment		
<b>MSFC-SPEC-250A (1977)</b>	Protective Finishes for Space Vehicle Structures and Associated Flight Equipment, General Specification For		
<b>CXP-00101</b>	Constellation Command, Control, Communication, and Information (C3I) Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)		

ID	APPROVED CHILDREN TABLE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
<b>CXP-00102</b>	Constellation Design Specification for Natural Environments (DSNE) (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)		
<b>CXP-01000</b>	Constellation Human System Integration Requirements (HSIR) (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)		
<b>JPR 8080.5</b>	JSC Design and Procedural Standards (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List) (exclusive of government shalls)		
<b>SAE-ARP-5412</b> (For guidance only)	Aircraft Lightning Environment		
<b>SAE-ARP-5413</b> (For guidance only)	Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning		
<b>SAE-ARP-5414</b> (For guidance only)	Aircraft Lightning Zoning		
<b>SAE-ARP-5415</b> (For guidance only)	Users Manual for Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning		
<b>SAE-ARP-5416</b> (For guidance only)	Aircraft Lightning Test Methods		
<b>SAE-ARP-5577</b> (For guidance only)	Aircraft Lightning Direct Effects Certification		
<b>SAE-ARP-5412</b> (For guidance only)	Aircraft Lightning Environment		
<b>IEEE/ASTM SI10</b>	American National Standard for Use of the International System of Units (SI): The Modern Metric System		

**2.0 GUIDANCE DOCUMENTS**

Guidance documents are listed for two purposes.

- 1) To be used by the contractor as a level of standards that must be met or exceeded if alternative standards are recommended by the contractor. If the alternative standards are approved by NASA, then the guidance document will no longer be tracked as a contractual document.
- 2) To be used or tailored per direction within a DRD description. The resulting new or tailored document deliverable will take precedence over the associated guidance document once the new or tailored document deliverable is approved by NASA. After the new or tailored document is approved by NASA, the original "guidance document" is no longer a contractual document.

ID	GUIDANCE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
533 DRD-eCCR	533 Electronic Submission Example	CEV-B-001	
AIA/NAS NASM20995	Wire, Safety or Lock		6.2.10
ANSI/AIAA G043-1992	Guidance for Preparation of Operational Concept Documents	CEV-O-001	7
ANSI/ASQC Z1.4	Sampling Procedures and Tables for Inspection by Attributes		6.2.10
ANSI/ESD S20.20-1999	ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)	CEV-S-015, CEV-S-017, CEV-T-025	2.1.9.2
ANSI/NCSL Z450-1	Calibration Laboratories and Measuring and Test Equipment - General Requirements		6.2.10
ASTM E1742	Standard Practice for Radiographic Examination		6.2.10
ASTM E8	Standard Test Methods of Tension Testing of Metallic Materials		6.2.10
CPIA 655	Guidelines for Combustion Stability Specifications and Verification Procedures for Liquid Propellant Rocket Engines	CEV-T-071	6.2.7
CXP-00004	Constellation Operations Concept Document	CEV-O-001	
CXP-02004	Constellation Probabilistic Risk Assessment (PRA) Plan	CEV-S-002, CEV-S-010	
CXP-02009	Constellation Software Classification Matrix (use as guidance in interpreting flight software classification definitions in NPR 7150.2)	CEV-T-005	2.1.4
CXP-02011	Constellation Systems Supportability Strategy	CEV-T-011, CEV-T-012, CEV-T-014	2.1.6
CXP-02012	Methodology for Conduct of Project Constellation Hazard Analyses		3.1
CXP-12000	NASA CEV Project Management Plan (PM-0001)	CEV-M-001	
DOD 4145.26-M	DOD Contractors' Safety Manual for Ammunition and Explosives		6.2.10
FTH	Fault Tree Handbook with Aerospace Applications, August 2002, version 1.1 (Chapters 1-9)	CEV-S-002, CEV-S-010	3.1

## Crew Exploration Vehicle - (CEV)

ID	GUIDANCE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
IEEE/EIA 12207.0-1996	Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes	CEV-T-005, CEV-T-006, CEV-T-048, CEV-T-049, CEV-T-050, CEV-T-051, CEV-T-052, CEV-T-053, CEV-T-054, CEV-T-055, CEV-T-056, CEV-T-057	2.1.4
IEEE/EIA 12207.1-1997	Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data	CEV-T-005, CEV-T-006, CEV-T-029, CEV-T-035, CEV-T-048, CEV-T-049, CEV-T-050, CEV-T-051, CEV-T-052, CEV-T-053, CEV-T-054, CEV-T-055, CEV-T-056, CEV-T-057	2.1.4
ISO 14300-1	Space Systems - Programme Management - Part 1: Structuring of a Program		1.1.1
JPR 1700.1	JSC Safety and Health Handbook	CEV-S-008	
JSC 17773	Preparing Hazard Analyses for JSC Ground Operations	CEV-S-008	
KHB 1700.7	Space Shuttle Payload Ground Safety Handbook	CEV-S-001, CEV-S-005	
MIL-HDBK-61A	Military Handbook Configuration Management Guidance	CEV-M-003	1.1.4
MIL-P-116	Preservation, Methods of		6.2.10
MIL-S-22473	Sealing, Locking and Retaining Compounds, Single Component		6.2.10
MIL-STD-810F	DOD Test Method Standard for Environmental Engineering Considerations and Laboratory Tests, Section 5 and Part 2	CEV-T-073	6.2.9
MS20003	Indicator, Humidity, Card, Three Spot, Impregnated Areas		6.2.10
MSFC-PROC-1831	The Analysis of Nonvolatile Residue Content	CEV-T-073	6.2.9

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ID	GUIDANCE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
<b>MSFC-PROC-1832</b>	Sampling and Analysis of Nonvolatile Residue Content on Critical Surfaces	CEV-T-073	6.2.9
<b>MSFC-PROC-404</b>	Gases, Drying and Preservation, Cleanliness Level and Inspection	CEV-T-073	6.2.9
<b>MSFC-SPEC-164B</b>	Specification for Cleanliness of Components for Use in Oxygen, Fuel and Pneumatic Systems (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)	CEV-T-073	6.2.9
<b>MSFC-STD-531</b>	High Voltage Design Criteria	CEV-T-024	2.1.9.1
<b>NASA-HDBK-7005</b>	Dynamic Environmental Criteria	CEV-T-015	6.2.6
<b>NASA-STD-8739.1</b>	Workmanship Standards for Staking and Conformal Coating of Printed Wire Boards and Electrical Assemblies	CEV-S-015, CEV-S-017	
<b>NASA-STD-8739.2</b>	Workmanship Standard for Surface Mount Technology	CEV-S-015, CEV-S-017	
<b>NASA-STD-8739.3</b>	Soldered Electrical Connections	CEV-S-015, CEV-S-017	
<b>NASA-STD-8739.4</b>	Crimping, Interconnecting Cables, Harnesses, and Wiring	CEV-S-015, CEV-S-017	
<b>NASA-STD-8739.5</b>	Fiber Optic Terminations, Cable Assemblies, and Installation	CEV-S-015, CEV-S-017	
<b>OSHA TED 8.4</b>	Voluntary Protection Programs (VPP): Policies and Procedures Manual	CEV-S-008	
<b>PRAPG</b>	Probabilistic Risk Assessment Procedures Guide for NASA Managers and Practitioners, Sections 4 - 14	CEV-S-010	
<b>RTCA/DO-160D</b>	Environmental Conditions and Test Procedures for Airborne Equipment (Section 22: Lightning Induced Transient Susceptibility and Section 23: Lightning Direct Effects)	CEV-T-025	
<b>SAE-ARP-5412</b>	Aircraft Lightning Environment	CEV-T-025	
<b>SAE-ARP-5413</b>	Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning	CEV-T-025	
<b>SAE-ARP-5414</b>	Aircraft Lightning Zoning	CEV-T-025	

ID	GUIDANCE DOCUMENT TITLE	REFERENCES	
		DRD	SOW
<b>SAE-ARP-5415</b>	Users Manual for Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning	CEV-T-025	
<b>SAE-ARP-5416</b>	Aircraft Lightning Test Methods	CEV-T-025	
<b>SAE-ARP-5577</b>	Aircraft Lightning Direct Effects Certification	CEV-T-025	
<b>SSP 30240</b>	Space Station Grounding Requirements	CEV-T-025	2.1.9.2
<b>SSP 30242</b>	Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility	CEV-T-025	2.1.9.2

### **3.0 INFORMATIONAL DOCUMENTS**

Informational documents are listed for information purposes only.

CXP-00001, Constellation Architecture Requirements Document (CARD)



## **ATTACHMENT J-4**

### **WORK BREAKDOWN STRUCTURE**

This attachment establishes the CEV Project Work Breakdown Structure (WBS) and the framework for the Contractor WBS (CWBS).

**NOTE: The Constellation WBS defines the Level 1 CEV as element 1.0. The CEV Statement of Work (SOW) is organized using the CEV Project WBS structure in this Attachment, presuming the 1.0 Constellation prefix throughout.**

For example: SOW 6.1.2 Spacecraft Integration = WBS 1.6.1.2 Spacecraft Integration

Level					Title	Description
1	2	3	4	5		
1.0					Crew Exploration Vehicle	
1.1					Project Management	Project Management contains the efforts required for Project Management, Project Administration, Business Management, Contractor Management and Relationships, and Information Technology Management. This element also includes task efforts in managing Technical Reviews, and Special Studies required by NASA.
1.1.1					Project Management and Administration	This element contains the efforts for planning, organizing, directing, coordinating, controlling, and approval processes used to accomplish overall Project objectives.
1.1.1.1					Project Management, Systems, Planning and Reporting	This element includes the development of systems and processes required for the planning, organization, control surveillance and reporting of overall contract activities to ensure disciplined performance of work. This includes the efforts for development of a Project Management Plan to assure all systems and processes are adequate to complete all CEV Project safety, technical, schedule, and cost objectives.
1.1.1.2					Performance Management Reviews and Performance Metrics	This element consists of the efforts for conducting quarterly Performance Management Reviews (PMRs) with the Crew Exploration Vehicle Project Office (CEVPO). This includes the efforts to define metrics indicating the level of success and quality of the execution of contract requirements and the status of the Contractor's performance against the performance standards contained within this contract.

Level					Title	Description
1	2	3	4	5		
			1.1.1.3		NASA Integrated Collaborative Environment (ICE)	This element is the effort to share, report, collect, record and access project information among NASA, CEV Contractor, major/critical subcontractors, associate contractors and authorized Government personnel connected with the CEV Project. ICE provides real-time collaborative access to a single source of management information, product information and technical data. ICE is the principal mechanism for integrating a project's digital information management environment.
			1.1.1.4		Configuration Management	This element consists of the efforts to perform the configuration management. This includes the CM efforts across all pertinent project elements such as modeling and simulation, manufacturing, operations, quality and acquired items.
			1.1.1.5		Data Management	This element consists of the efforts to perform the data management. This includes the DM efforts across all pertinent project elements such as modeling and simulation, manufacturing, operations, quality and acquired items.
			1.1.1.6		Risk Management	This element consists of the efforts to provide for a proactive decision-making process to continuously assess CEV Project risks, prioritize risks, and implement strategies to mitigate and control those risks. Risk Management will be applied to all phases of the CEV Project as an integral part of project management.
			1.1.1.7		Integrated Master Plan (IMP)	This element consists of the efforts to manage the execution of the CEV using the IMP and its associated Integrated Master Schedule (IMS). The IMP and IMS provide a systematic approach to project planning, scheduling, and execution. A mutual understanding of what is required to successfully plan and execute the project is critical to the government-industry team.

Level					Title	Description
1	2	3	4	5		
			1.1.1.8		Integrated Master Schedule (IMS)	This element consists of the tasks necessary to develop an integrated schedule used to accomplish the total scope of work as defined in the WBS. The schedule will contain the contract IMP events, milestones, accomplishments, criteria, and activities. This schedule will be used to provide management insight into contractor status, potential problem areas, risk and critical path identification, which will serve as the basis for evaluating the Contractor's performance.
			1.1.1.9		Internal/External Project Review Support (IDIQ)	This element consists of the efforts to develop briefing materials and analyses for CEV meetings with various internal and external review groups, which may include groups like the flight technique panels, Aerospace Safety Advisory Panel (ASAP), Inspector General/Government Accountability Office (IG/GAO), Space Flight Advisory Committee (SFAC), and cost assessments teams.
			1.1.2		Business Management	This element includes efforts to manage the business and resource control processes for the Project.
			1.1.2.1		Financial Management	This element is the effort to provide summary-level cost reporting by fund source, contract WBS, elements of cost and manpower including labor Equivalent Personnel (EP), overhead, and other direct and indirect costs.
			1.1.2.2		Workforce Reporting	This element consists of effort to report the workforce information by geographic location.
			1.1.2.3		Reserved	
			1.1.2.4		Integrated Baseline Review (IBR)	This element is the effort to establish the baseline plan, cost and schedule risk, and the underlying management processes used for planning and controlling the project.

Level					Title	Description
1	2	3	4	5		
		1.1.2.5			Cost Performance Report	This element is the effort to provide information for: (1) integrating cost and schedule performance data with technical performance measures, (2) assessing the magnitude and impact of actual and potential problem areas causing significant cost and schedule variances, and (3) providing valid, timely status information to the CEV Project.
		1.1.2.6			Life Cycle Cost Management	This element is the effort to capture, maintain, and provide access to life cycle cost analysis data as it evolves through the project life cycle.
		1.1.3			External Relationships	This element includes the effort to define and implement the Contractor relationships with the Constellation contractors. Associate relationships may include need for data products of other Constellation contracts, the interrelationship of schedule information, or the impact due to a change in project requirements.
		1.1.3.1			Associate Contracts	This element consists of the efforts to establish relationships with other Constellation contractors, defined as associate contractor relationships. This effort includes the establishment of formal guidelines to address coordination, cooperation and communication with associate contractors.
		1.1.3.2			NASA Centers	This element consists of the efforts to establish cooperative relationships at the NASA centers to understand NASA GFE and data deliverables, schedules, interfaces, and interactions.

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Level					Title	Description
1	2	3	4	5		
		1.1.4			Technical Reviews	This element includes the effort to support the planning and execution of technical integration reviews conducted by NASA. This element also includes the effort to participate in NASA Constellation reviews and implement the defined set of CEV Project reviews. The element includes demonstration of review objectives, entrance and exit criteria to, development and presentation of data, responses to Review Item Discrepancies (RIDs) generated by NASA authorized reviewers, and implementation of actions resulting from RIDs.
		1.1.5			Information Technology Management	This element consists of implementing Information Technology requirements for the Project including capital planning, investment control and security. Information Technology security is defined as the protection of IT investments (e.g., information systems and telecommunications systems) and their associated information and data from unauthorized access, use, disclosure, disruption, modification, or destruction to ensure the integrity, confidentiality, and availability of NASA IT systems.
		1.1.6			Reserved	
		1.1.7			Special Studies (IDIQ)	This element consists of the efforts to accomplish any special studies or analyses requested by NASA through the Contracting Officer.
		1.2			Systems Engineering and Integration	Systems Engineering and Integration consists of the technical and management efforts of directing and controlling the integrated engineering effort for the System to achieve a solution that satisfies all CEV Project requirements and otherwise balances performance, cost, schedule, and risk. SE&I includes the development of upgrade paths for future missions and integration of the CEV System into the Constellation Program.

Level					Title	Description
1	2	3	4	5		
		1.2.1			Crosscutting Systems Engineering and Integration Development Activities	This element includes cross-cutting Systems Engineering and Integration Development activities to provide consistency across all aspects of the CEV System development efforts.
		1.2.1.1			Systems Engineering Management	This element consists of the efforts to manage the CEV's overall system architecture definition and engineering functions including the interfaces with external Constellation Systems.
		1.2.1.2			Integrated Models and Simulations	This element consists of the efforts to develop design and analysis tools, models and simulations used in the development of the CEV System, including source code.
		1.2.1.3			Open Architecture	This element consists of the efforts to develop and implement an approach for a modular open systems architecture in the design of the CEV System. It includes making the impact to the overall modular open systems architecture a primary consideration in the selection of equipment to meet the CEV design functionality.
		1.2.1.4			Software Engineering	This element includes all aspects of software production from the early stages of system specification through maintenance of the system in the field. Software Engineering includes the work required to define an overall CEV System approach to the design, development, test certification, and delivery of software in support of the CEV System. CEV software includes all flight software and onboard firmware, ground software, and test software.
		1.2.1.5			System Analysis	This element includes the work to identify and conduct trade studies and cost-effectiveness analyses including reliability, maintainability and supportability, across the CEV System to ensure that a complete set of options and alternatives is assessed for driving CEV System requirements and design decisions.

Level					Title	Description
1	2	3	4	5		
			1.2.1.6		Integrated Logistics Support	This element consists of the work required to develop concepts, requirements and plans for maintenance and logistics for CEV Project supportability. This includes life cycle plans for design-in-supportability, hardware processing and definition of logistics support resources.
			1.2.1.7		Systems Test Verification and Certification	The element covers the work to certify the CEV System by inspection, demonstration, simulation, analysis and/or test. This element includes development of a plan for the verification and certification of the CEV System (hardware, firmware, and software) and associated subsystems and components.
			1.2.1.8		Human Engineering	The element consists of the work required to plan and design the System for use by humans during operations and maintenance.
			1.2.1.9		Specialty Engineering	The element consists of the work to apply the specialty engineering disciplines of materials and processes, electromagnetic compatibility, EEE parts, and environments to the CEV System design.
			1.2.1.9.1		Materials and Processes	This element includes the tasks required to support spacecraft M&P design and implementation, including: oversight into M&P efforts and the review and assessment of the subsystems' M&P listing to ensure that proper materials and processes are selected and used for flight hardware.
			1.2.1.9.2		Electromagnetic Compatibility	This element is the work required to ensure the design, development and delivery of a CEV System is electromagnetically compatible with all subsystems and equipment within the CEV System and with environments caused by electromagnetic effects external to the System. CEV System volumes which are intended to be used for humans, active or passive equipment, and active or passive organic/inorganic substances, shall be compatible with electromagnetic effects caused by CEV Systems, CEV Systems shall be compatible with the intended use of these CEV System volumes.



Level					Title	Description
1	2	3	4	5		
				1.2.1.9.3	Electrical, Electronic, and Electromechanical (EEE) Parts	This element includes the work required to develop, and implement a EEE Parts Management and Implementation Plan for the CEV.
				1.2.1.9.4	Environments	This element includes the tasks required to determine the specific natural environments and induced environments that the CEV System must operate within and for which the CEV System must be qualified, encompassing all phases of CEV System production, testing and operation in all modes through disposal. It also includes derivation and control of environment data and analysis models for the design, certification, and operation of the CEV System, subsystems, assemblies, and components.
				1.2.2	Program Integration	This element consists of the efforts to integrate the CEV System into the Constellation and International Space Station Programs.
				1.2.2.1	Constellation Program Integration	This element consists of the efforts to develop appropriate External Interface Control Documents (EICDs) for each Constellation external interface. This element includes tasks to perform analyses and tests and provide reports and engineering data supporting integration, verification and operation of CEV and other Constellation elements and provide technical data, and models required to perform Constellation level analyses. This element also includes efforts to develop, deliver, and sustain CEV functional and physical interface simulator(s).

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Level					Title	Description
1	2	3	4	5		
		1.2.2.2			CEV to International Space Station Program Integration	This element consists of the efforts to develop appropriate External Interface Control Documents (EICDs) to the International Space Station (ISS) Program. This element includes tasks to perform analyses and tests and provide reports and engineering data supporting integration, verification and operation of CEV and the ISS and provide technical data, and models required to perform integrated ISS/CEV level analyses. This element also includes efforts to develop, deliver, and sustain CEV functional and physical interface simulator(s).
		1.2.3			Requirements Definition and Management	This element includes the work necessary to validate CEV System requirements and interface requirements and properly allocate them to the Spacecraft and Ground Systems.
		1.3			Safety and Mission Assurance	Safety and Mission Assurance includes integration of Safety and Mission Assurance into the CEV System design, development, risk identification and mitigation, test, ground and flight operations, and ground processing activities.
		1.3.1			System Safety	This element provides the technical and management effort necessary to ensure the overall safety and protection of flight and ground personnel, general public, flight/ground hardware, software and facilities through all phases of the project, including oversight of contracted efforts. This element includes Identification and generation of Project Hazard Fault Trees, Hazard analysis Reports, Hazard Mitigation and Controls, safety data packages and support the Project Safety Review Process.
		1.3.2			Industrial, Environmental, Processing Site, Launch Site and Range Safety	This element includes the efforts necessary to ensure that occupational (industrial) safety and health, environmental assurance function and test range safety for all aspects of the CEV Project are accomplished.

Level					Title	Description
1	2	3	4	5		
1.3.3					Reliability, Maintainability, and Supportability (RMS)	This element includes the activities to define, develop, and implement RMS tasks as an integral part of the design, development, test, evaluation, and operations processes.
1.3.4					Hardware Quality Assurance	This element includes the technical and management efforts to define, develop, and implement Quality Assurance requirements and processes as an integral part of the CEV System life cycle. It also includes efforts to define, develop, and implement an effective quality assurance program that establishes quality requirements for EEE parts, contributes to the logistics processes, maintains effective configuration management, and establishes a sound problem reporting and corrective action system.
1.3.5					Software Assurance and Safety	This element includes the technical and management efforts to define, develop, and implement a systematic approach to software safety as an integral part of the Projects overall system safety Project, software development, and software assurance processes. It also includes the effort to demonstrate that test plans, requirements, preliminary design procedures, and results assure the implementation of software requirements.
1.4					Reserved	
1.5					Reserved	
1.6					Spacecraft	Spacecraft includes the tasks required for the design, development, production, assembly, test, and certification efforts to deliver the completed Spacecraft for integration with the launch vehicle.
1.6.1					Spacecraft Systems Engineering	This element consists of the efforts to lead the spacecraft's overall system architecture definition and engineering functions. This includes the technical and management efforts of directing and controlling the integrated engineering effort for the spacecraft.

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Level					Title	Description
1	2	3	4	5		
			1.6.1.1		Requirements Definition and Management	This element includes the work necessary to allocate and validate the requirements from the spacecraft level down to the component level and all interfaces between each level of requirements.
			1.6.1.2		Spacecraft Integration	This element is the work required to define and manage the internal spacecraft interfaces.
			1.6.1.3		Spacecraft Crew Cabin and Cockpit Layout Design Requirements	This element is the work required to participate in the development of detailed design requirements for the CEV crew cabin and cockpit layout and document these requirements.
			1.6.1.4		Spacecraft Test, Verification and Certification	This element is the work required to verify, by simulation, analysis and/or test that all CEV requirements are verifiable and have been satisfied.
			1.6.1.5		Spacecraft Specialty Engineering	The element consists of the work to apply the crosscutting specialty engineering disciplines of aerosciences, instrumentation, mass properties, Micrometeoroid and Orbital Debris (MMOD) analyses, and radiation to the spacecraft.
			1.6.1.5.1		Aerosciences	This element contains the effort to define the aerodynamic and aerothermodynamic characterization of the vehicle through all phases of atmospheric flight including plume/flowfield interactions and on-orbit rarefied flows. The aerodynamic environment includes the vehicle forces, vehicle moments, related surface pressure, and related shear forces. The aerothermodynamic environment includes heat transfer to the vehicle surface. The on-orbit environment addresses the flight regimes where the flow cannot be described as a continuum and includes the Reaction Control System (RCS) plume contamination and impingement environments.
			1.6.1.5.2		Instrumentation	This element defines the collection and processing of vehicle transducer and sensor information and vehicle health monitoring data specified by other subsystems for use on the vehicle and ground.

Level					Title	Description
1	2	3	4	5		
				1.6.1.5.3	Mass Properties	This element includes the definition, control and verification of mass properties. The mass properties of an item include its mass, center of gravity, mass moments of inertia, and mass products of inertia with respect to a reference coordinate system.
				1.6.1.5.4	Micrometeoroid and Orbital Debris (MMOD) Analyses	This element is the work required to assess the risk to the spacecraft and crew resulting from damage or penetration from micrometeoroid and orbital debris impacts during various mission phases and the certification analyses activities performed to verify the CEV meets all MMOD protection requirements dictated by the CEV Project.
				1.6.1.5.5	Radiation	This element consists of the work required to perform analyses used to describe the internal CEV radiation environments that result from exposure to natural radiation background environments and events.

Level					Title	Description
1	2	3	4	5		
		1.6.2			Spacecraft Subsystems	<p>This element consists of the work required to design, develop, produce, and test through certification and acceptance a CEV Spacecraft meeting all CEV System-level and external-interface requirements. Spacecraft Subsystems development includes subsystem requirements generation and allocation to the component level; design and development of breadboards, engineering, qualification, and acceptance testing equipment and facilities, spacecraft wiring, flight hardware, non-flight functional equivalent units, spares, and flight and ground software; and subsystem test and integration. The vehicle subsystems have been separated as follows: Avionics; Electrical Power Subsystem; Mechanisms; Passive Thermal Control; Thermal Protection System; Structures (including loads and dynamics, stress analysis); Propulsion; Suits, EVA and Survival Crew Equipment Support Systems; Environmental Control and Life Support (ECLS), Crew Health and Habitation Accommodations Systems; Pyrotechnics; Recovery Systems; Guidance, Navigation, and Control (GN&amp;C); Wiring; and Launch Abort System. Direct efforts associated with integrating each of these subsystems into the vehicle are covered under WBS element 1.6.1.2, Spacecraft Integration. Direct efforts associated with integrated testing of each of these subsystems in the vehicle are covered under WBS element 1.6.1.4, Spacecraft Test, Verification, and Certification.</p>

## Crew Exploration Vehicle – (CEV)

Level					Title	Description
1	2	3	4	5		
			1.6.2.1		Avionics	This element is the effort to design, develop, integrate, test, certify, and deliver the software, computers, and other electrical and electronic equipment used for commanding, monitoring, and communicating with the CEV's subsystems. The avionics subsystem includes the hardware and software components that provide the following functions: Flight Software, Command & Data Handling (C&DH), Instrumentation, Communications and Tracking (C&T), Displays & Controls (D&C), and all data/signal interfaces between these functions and external Spacecraft systems/modules/subsystems/components.
			1.6.2.1.1		Flight Software	This element is the effort to design, develop, integrate, test, certify, and deliver the software that comprises all avionics functions, including systems management, Command & Data Handling (C&DH), instrumentation, Communications & Tracking (C&T), crew interfaces, external interfaces, and the application software for all other subsystems. Flight software includes firmware, newly developed software, software reused from another program, and acquired software (e.g. operating systems, device drivers, etc.).
			1.6.2.1.2		Command & Data Handling (C&DH)	This element is the effort to design, develop, integrate, test, certify, and deliver the data processing and computing resources including processors, memory, input/output devices, data multiplexers/demultiplexers, mass storage devices, inter-computer time-synchronization devices, and networking equipment. The CEV Instrumentation collects and processes vehicle transducer and sensor information and vehicle health monitoring data specified by other subsystems for use in flight and on the ground. The instrumentation hardware handling signal processing is considered part of the C&DH subsystem. Sensors used within another subsystem's firmware controller are considered part of that subsystem.

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Level					Title	Description
1	2	3	4	5		
				1.6.2.1.3	Communications and Tracking (C&T)	This element is the effort to design, develop, integrate, test, certify, and deliver the space-to-ground and space-to-space communication links, RF/optical tracking devices (excluding navigational aids), and audio and video/imagery equipment.
				1.6.2.1.4	Displays & Controls	This element is the effort to design, develop, integrate, test, certify, and deliver the crew interface with the on-board computer systems and the manual controls/feedbacks used by the crew to control the vehicle, interact with its subsystems, and monitor automated processes. This work is done in concert with WBS elements 1.2.1.8, Human Engineering, and 1.6.1.3, Spacecraft Crew Cabin and Cockpit Layout Design Requirements.
				1.6.2.2	Electrical Power Subsystem	This element is the effort to design, develop, integrate, test, certify, and deliver the power generation, energy storage, electrical power distribution and control, and external/internal CEV lighting.
				1.6.2.3	Mechanisms	This element is the effort to design, develop, integrate, test, certify, and deliver any mechanical or electromechanical devices that control the movement of a mechanical part of the spacecraft relative to another part. These devices include latches, hatches, doors, and fasteners installed, removed, or adjusted during flight. The spacecraft docking system is not included in this category as it is provided by NASA. Mechanical landing and impact attenuation systems are covered in WBS element 1.6.2.11, Landing and Recovery Systems.
				1.6.2.4	Passive Thermal Control	This element is the effort to design, develop, integrate, test, certify, and deliver hardware, coatings, blankets, heaters, and other design accommodations that protect the vehicle, crew, and its constituent components from thermal environmental extremes during all mission phases.



Level					Title	Description
1	2	3	4	5		
			1.6.2.5		Thermal Protection System	This element is the effort to design, develop, integrate, test, certify, and deliver hardware that protects the vehicle and its constituent components from the aerothermal environment during ascent and entry.
			1.6.2.6		Structures	This element is the effort to design, develop, integrate, test, certify, and deliver the primary structure, secondary structure, and all structural components of vehicle equipment, including spacecraft and component loads, dynamics, and stress analysis.
			1.6.2.7		Propulsion	This element is the effort to design, develop, integrate, test, certify, and deliver vehicle components that provide propulsive thrust used for trajectory insertion, orbital maneuvering, and translation and rotation reaction control. Retro rockets for landing attenuation systems are covered in WBS element 1.6.2.11, Landing and Recovery Systems.
			1.6.2.8		Suits, EVA and Survival Crew Equipment Support Systems	This element is the effort to design, develop, integrate, test, certify, and deliver components that interface to EVA and Crew Support Equipment.

Level					Title	Description
1	2	3	4	5		
			1.6.2.9		Environmental Control and Life Support (ECLS), Crew Health and Habitation Accommodations	This element is the effort to design, develop, integrate, test, certify, and deliver the spacecraft subsystems for Environmental Control and Life Support (ECLS), active thermal control, medical systems interfaces, and habitation accommodations. The subsystem provides for the following functions: Breathable atmosphere; Emergency oxygen; Contaminant control (in the air, in fluids and on surfaces); Potable and non-potable water; Waste and trash collection, storage, processing and disposal; Fire/smoke detection and suppression; Cabin pressure, temperature and humidity; Heat acquisition, transport and rejection; Equipment and vehicle systems active thermal control; Thermally-controlled storage; Food supply interfaces and onboard processing and preparation systems and storage; Environmental monitoring, including radiation monitoring; Medical systems interfaces (including crew health system interfaces and countermeasure systems interfaces); Habitation accommodations (e.g., crew "seats", internal restraints and mobility aids, hygiene systems, privacy accommodations, sleep systems, ambient storage systems, maintenance systems, inspection systems, repair systems, in-situ training systems, housekeeping systems, clothing interfaces, crew personal items interfaces, inventory systems, and noise control systems).

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Level					Title	Description
1	2	3	4	5		
			1.6.2.10		Pyrotechnics	This element is the effort to design, develop, integrate, test, certify, and deliver all devices and assemblies containing or operated/actuated/severed by, propellants and/or explosives. This subsystem includes items such as items such as initiators, detonators, safe and arm devices, cartridges, separation bolts and nuts, pin pullers, retractors, thrusters, oxygen candles, reefing line cutters, pyrotechnic hardware used in crew escape and crew survivability, linear separation systems, guillotines, valves, disconnects, transfer assemblies, through bulkhead initiators, shaped charges, mortars, circuit interrupters, and dimple motors. This subsystem specifically excludes large rocket motors.
			1.6.2.11		Landing and Recovery Systems	This element is the effort to design, develop, integrate, test, certify, and deliver parachute, landing attenuation, impact attenuation, and floatation systems. The parachute system includes slings attaching a parachute to the vehicle; connectors; parachute risers, suspension lines, and canopies; reefing lines; deployment bags and lines; and pyrotechnic devices.
			1.6.2.12		Guidance, Navigation, and Control (GN&C)	This element is the effort to design, develop, integrate, test, certify, and deliver the Guidance, Navigation, and Control (GN&C) subsystem. This includes the hardware components, software, and algorithms for guiding, navigating, and controlling the CEV Spacecraft.

Level					Title	Description
1	2	3	4	5		
		1.6.2.13			Wiring	This element is the effort to design, develop, integrate, test, certify, and deliver the wiring harnesses and optical cabling for both electrical and optical signals and provides the power, data, and command paths, connections, production breaks, and access points required to develop, assemble, test, operate, verify, certify, service and safeguard the CEV Spacecraft throughout its life cycle. In addition to wiring harnesses and optical cabling, the element includes the static electrical and optical service panels, outlets, and connectors needed to support testing, troubleshooting, processing and operation of the CEV Spacecraft, and the dynamic electrical and optical service panels/connectors needed to make/break electrical and optical connections between the CEV Spacecraft modules or between the CEV Spacecraft and other Constellation elements or external equipment from launch through recovery. This element also includes the effort to design, and plan for the development and test of all grounding, shielding, circuit protection, and circuit isolation provisions needed for the safe operation of the CEV Spacecraft in its development, test, and operational environments.
		1.6.2.14			Launch Abort System	This element is the effort to design, develop, integrate, test, certify, and deliver the CEV Launch Abort System to provide escape capability from the launch vehicle during launch and ascent operations. The Launch Abort System includes components, resources, and data from other systems in addition to hardware specifically designed to accomplish abort/escape functions.
		1.6.3			Government Provided Products (Reserved)	Reserved
		1.6.4			Spacecraft Integration and Test Facilities	This element consists of all activities needed to provide the Integration, Test, & Verification facilities required to complete integrated verification of the spacecraft.

Level					Title	Description
1	2	3	4	5		
1.6.5					Spacecraft Assembly, Integration, and Production	This element consists of all activities needed to produce an integrated, verified, validated, and accepted vehicle and all deliverable hardware, software, and documentation products.
1.7					Operations	Operations encompasses the work required to develop processes, plans, system requirements, training, procedures, and work associated with the preparation, launch and flight execution, and recovery of the CEV. The scope of operations includes the activities commencing once CEV System hardware/software has been delivered to the Government and is in support of the integrated test flights. This element also includes the effort to develop an overall concept of operations, and plans for detailed ground operations, detailed flight operations, considering operations during design, range safety, training, and transition.
1.7.1					Operational Analyses Supporting Design	This element includes work to perform operational analyses to ensure a balance of cost, schedule and risk between spacecraft design and ground and flight infrastructure needed to accomplish the operational mission.
1.7.2					Ground Operations	This element includes efforts required to provide (1) plans for CEV stand-alone ground operations where the activities involve the CEV system and (2) requirements for integrated ground operations where the activities involve the spacecraft with other Constellation flight elements.
1.7.3					Flight Operations	This element includes efforts to develop the plans, processes, schedules, and products required to perform the flight design, analyses, and flight planning activities; flight products and procedure development; and execution of the integrated flights. Flight Operations will be the responsibility of NASA to perform; however, it is essential that the Contractor provide the data and support to NASA for the development of the flight operations products to prepare for and execute the CEV missions.

Level					Title	Description
1	2	3	4	5		
		1.7.3.1			Flight Operations Preparation	This element includes efforts to develop the pre-flight plans, processes, schedules, flight design and analyses, flight plans, procedures, and support products necessary to prepare for the CEV mission execution. The culmination of these activities will produce a complete, integrated set of operations products and procedures necessary to execute during a CEV mission.
		1.7.3.2			Flight Operations Execution (IDIQ)	This element includes tasks to perform real-time support for all phases of mission operations beginning with pre-launch activities through post-landing egress of the flight crew. It is the culmination of all of the earlier pre-flight flight design, mission planning, training, and ground operations activities.
		1.7.4			Range Safety	This element includes the technical and management efforts to coordinate, develop and prepare the procedures for incorporation of and compliance with range safety requirements during preparation and execution of CEV test and operational flights from US airspace and ranges. This includes coordinating meetings and reviews with range safety personnel and the CEV development team personnel. It also includes coordinating range safety support to hazardous activities at the launch and flight test sites, launch operations, and hazards analysis for the launch/ascent phase and, if required, the descent/landing phase.
		1.7.5			Training	This element includes the effort to develop plans, processes, and schedules required to train and certify ground operations personnel engaged in the inspection, test, checkout, maintenance, and operations of all assigned flight hardware, GSE, facilities, facility systems, and equipment to support the preflight processing, launch, and recovery operations of the CEV system. This element also includes the plans, processes, and schedules required to train and certify flight crew, flight controller and other flight operations personnel to support the preflight and real-time operations of the CEV system

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Level					Title	Description
1	2	3	4	5		
1.8					Launch and Vehicle Services	Reserved
1.9					Ground and Training Systems	<p>Ground and Training Systems includes the effort to develop requirements, designs and plans for the development and test of facilities, hardware and software to support ground and flight operations. Ground Systems include facilities, facility systems, and ground support equipment hardware and software required to support integrated test flights and operational flights for ground and flight operations. Training Systems include facilities, hardware and software to support ground and flight operations training.</p> <p>The work for Ground and Training Systems includes the allocation of requirements for ground support equipment, facilities, and training systems to end items. For end items which are CEV-unique, the work further includes planning and preliminary design. For end items which are provided by other elements of the Constellation Program, the work further includes participation in applicable technical interchange meetings and technical design reviews.</p>
1.9.1					Facilities and Facility Systems	<p>This element includes development of plans and designs needed for CEV System-unique or stand-alone ground and flight operations. Facilities and facility systems encompasses stand-alone processing facilities, control rooms, landing and recovery facility systems and other monitoring systems.</p>
1.9.2					Ground Support Equipment	<p>This element includes development of plans and designs for CEV System-unique ground support equipment, both hardware and associated software, needed for ground and flight operations during integrated test flights and operational flights.</p>

## Crew Exploration Vehicle – (CEV)

Level					Title	Description
1	2	3	4	5		
		1.9.3			Training Systems (IDIQ)	This element includes development of plans and designs for CEV System-unique training systems needed for ground operations and flight operations during integrated test flights and operational flights. The CEV-unique training systems include the hardware, software, and facilities required to educate, test, certify, qualify, standboard, maintain proficiency, and otherwise prepare the crew, ground, and flight operations personnel for successful execution of exploration missions.
		1.9.4			Storage	This element includes the development of plans for storage facilities for flight and ground systems and logistical spares provided by the CEV Contractor.
		1.10			Flight Test	<p>Flight Test includes the work associated with the Launch Abort System (LAS) test 1-3 and the first Risk Reduction Flight (RRF1) with the CLV. It includes work required for develop of Flight Test Article (FTA) requirements, design, production, verification, and deliver of the FTAs appropriate for these tests. All flight test activities will be conducted by NASA as a government provided service to the Contractor for DDT&amp;E.</p> <p>It also includes the definition of the test unique production CEV requirements For RRF1, RRF2 flight tests.</p>
		1.10.1			Flight Test Article Development and Production	This element includes the effort to define the fidelity, specifications and number of FTAs proposed to complete the flight test effort. This element also includes the effort to design, develop, certify, produce, and deliver FTAs for the flight test effort.
		1.10.1.1			Flight Test Article Requirements	This element includes the effort to define the fidelity and number of FTAs proposed to complete the flight test effort.
		1.10.1.2			Flight Test Article Design and Production	This element includes the effort to design, develop, certify, produce, and deliver FTAs for the flight test.



Level					Title	Description
1	2	3	4	5		
1.10.2					Test Article Ground Support Equipment	This element includes the effort to design, produce and deliver the FTA unique ground support equipment. It includes both hardware and associated software, needed for ground and flight operations during the LAS1, 2 and 3 testing.
1.10.3					Flight Test Support (IDIQ)	This element includes the effort to support the flight test activities including engineering and technician support for the FTA integration with the Abort Test Booster, FTA operations training, Test planning, execution and reporting.
1.11					Reserved	

## **ATTACHMENT J-5**

## **GLOSSARY**

## Glossary

**Acceptance** – The activity performed on all production articles generally consisting of inspections, measurements, and tests that demonstrate that each article was manufactured as designed and with acceptable quality and workmanship, performs in accordance with specified requirements, and is acceptable for delivery.

**Acceptance Review** – The Acceptance Review examines the equipment, documentation, and data that support verification. An acceptance review is accomplished to assure that equipment (at any level of assembly) is ready to for transfer of ownership or custody, or is ready for integration into a next-higher assembly.

**Acceptance Tests** – Tests performed on flight hardware and software to confirm equipment performs as qualified and is generally free of latent manufacturing, material, or “workmanship” defects for delivery of products. For hardware, acceptance testing is typically performed at operating and non-operating performance and environment limits without intruding into qualification margins. For software, acceptance testing ensures the software will load and execute on each serialized hardware platform.

**Analysis models** – An Analysis Model is a set of one or more engineering analysis tools that operate in conjunction with one another. Analysis models may be capable of automated execution or may require user-in-the-loop/interactive operation. The models typically estimate system performance according to an engineering discipline such as aerodynamics or cost. However, because a model may involve an engineering analysis tool from more than one discipline, the complete model may yield attributes across multiple disciplines. Creating such multi-tool models is particularly helpful when multiple disciplines within a system strongly interact with each other. The fidelity level of analysis model results may be very low (conceptual level) or may be very high (detailed design level).

**Certification** – A formal document signed by responsible parties (provider, integrator (if different), and the Project Office) attesting to the satisfactory completion of specified qualification activities, supported by certification records, and authorizing the use of hardware/software for recorded purposes within certified limits. Certification can be accomplished at any level of assembly from the component to the integrated system.

**Certification of Flight Readiness** – A commitment signed by each NASA project manager and the respective element contractor stating their readiness for launch. This document is signed during the Flight Readiness Review (FRR). Prior to FRR, each project manager is required to assess his readiness for launch by considering vehicle and facility hardware status, problems encountered during pre-launch preparation and their resolution, launch constraints, and open items.

**Certification Record** – A document or documents identifying the certified capability baseline, performance limits and operational constraints for a hardware/software configuration item. The certification record specifies the certified limits that govern usage during its life cycle. The certification record along with the signed certification establishes and illustrates the certified baseline.

**Certified Capability Baseline** – (a.k.a. As-Certified Baseline) The performance characteristics and conditions at a given point in time to which specified hardware/software is certified to meet program requirements. The certified capability baseline is the recognized definition of equipment

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and its capabilities, limits, and constraints for the purposes of establishing flight rules/crew procedures, documenting and resolving non-conformances, and sustaining equipment design. Qualification margins are not be intruded upon by production hardware in service and should not be reflected by the certified baseline.

**Certified Limits** – Parameters (e.g., input parameters such as current, voltage, load, force, torque, velocity, displacement, etc. or environmental conditions such as vibration, temperature, humidity, etc.) that define the bounds of certification of hardware performance or exposure during its life cycle. Limits may include operating time, cycles, or age. Limit conditions may be defined for both operational and non-operational hardware states and for individual equipment operating modes or system mission phases.

**CEV Engineering Models** – A CEV Engineering Model is a set of one or more engineering analysis tools that operate in conjunction with one another. CEV Engineering Models may be capable of automated execution or may require user-in-the-loop/interactive operation. CEV Engineering Models typically estimate system performance according to an engineering discipline such as aerodynamics or cost. However, because a model may involve more than one discipline engineering analysis tool the complete model may yield attributes across multiple disciplines. Creating such multi-tool models is particularly helpful when multiple disciplines within a system strongly interact with each other. The fidelity level of analysis model results may be very low (conceptual level) or may be very high (detailed design level). These models may or may not incorporate time as an independent variable. They encompass sensitivity analysis, trade space exploration and performance envelope characterization.

**CEV System** – Includes the spacecraft and all CEV-unique ground systems needed to support standalone and integrated operations.

**CEV System Flight Tests** – Operating flight tests during the development phase used to qualify that the integrated flight vehicle system (including the launch vehicle) and ground support equipment, as procured and verified by the acceptance test procedures, conform to the Constellation program requirements.

**Commercial-Off-The-Shelf (COTS)** – Commercially available products that can be purchased and integrated with little or no customization.

**Component** – An aggregate of hardware and/or software that can be characterized by one specification, is designed by a single activity to be functionally tested, and is verified as a unit.

**Computer Software Component (CSC)** – A distinct part of a CSCI. A CSC may be further decomposed into other CSC's and CSU's.

**Computer Software Configuration Item (CSCI)** – A configuration item for computer software (i.e., an identifiable, unique, high-level part of the software that is under configuration management). A CSCI may be further decomposed into CSC's.

**Computer Software Unit (CSU)** – An element (i.e., an elementary, basic, or primitive software part) specified in the design of a CSC that is separately testable.

**Conceptual model** – An abstraction of the real world that serves as a frame of reference for federation development by documenting simulation-neutral views of important entities and their key actions and interactions. The federation conceptual model describes what the federation will

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represent, the assumptions limiting those representations, and other capabilities needed to satisfy the user's requirements. Federation conceptual models are bridges between the real world, requirements, and design.

**Control Board** – The board, panel or forum chartered to have authority over a particular subject or item (ex. Flight Rules Control Board, Crew Procedures Control Board, etc.)

**Crew Activity Scheduling Constraints** – Constraints, restrictions or requirements on the scheduling of the flight crew. Includes such information such as required amounts of sleep, amount crew sleep can be shifted, amount of time for crew meals and exercise, etc.

**Crew Member** – Human onboard the spacecraft or space system during a mission.

**Crew Operations** – The activities performed by the flight crew while in the vehicle or during a mission. A subset of the Flight Operations Execution that begins with crew ingress into the CEV prior to launch and concludes with the crew egress from the CEV post landing.

**Critical Design Review (CDR)** – The CDR discloses the complete system design in full detail, ascertains that technical problems and design anomalies have been resolved, and ensures that the design maturity justifies the decision to initiate fabrication/manufacturing, integration, and verification of mission hardware and software.

**Depot Operations** – The operations performed offline to receive and accept new equipment, to perform maintenance, repairs and retests on equipment, or to refurbish and recertify expended (end of service life) equipment for reuse.

**Desktop Discrete Event Simulation** – A Desktop Discrete Event Simulation varies the inputs to Analysis and Part Models in accordance with an anticipated portion of the concept mission. Time is the independent variable in a Desktop Discrete Event Simulation. Desktop Discrete Event Simulations incorporate as many Analysis and Part Models as is needed to predict the total performance of a concept during a segment of the anticipated mission. These models are exposed to input sets that represent events as a function of time. A Desktop Discrete Event Simulation predicts the performance of multiple concept entities during multiple mission segments. This type of simulation predicts interactions between concept entities and their environment by incorporating the concept elements as well as external elements.

**Design for Manufacturability** – The process of proactively designing products to (1) optimize all the manufacturing functions: fabrication, assembly, test, procurement, shipping, delivery, service, and repair, and (2) assure the best cost, quality, reliability, regulatory compliance, safety, time-to-market, and customer satisfaction.

**Development Tests** – Any test that provides data needed to reduce risk, to design hardware or software, to define manufacturing processes, to define qualification or acceptance test procedures, or to investigate anomalies discovered during test or operations.

**Electromagnetic Interference (EMI)** – What occurs when electromagnetic fields from one device interfere with the operation of some other device.

**Emulator** – A device that replicates the command, monitoring, communications, data, and electrical power functions of a flight element, for use in interface verification of other flight or ground elements.

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**Engineering Analysis Tool** – An Engineering Analysis Tool is a single, self-contained computer program that produces a single set of outputs for a single set of inputs. An Engineering Analysis Tool makes predictions of system performance or environmental parameters, typically as they pertain to a single engineering discipline. An Engineering Analysis Tool is the smallest executable piece of an engineering computational framework.

**Engineering Simulations** – Engineering Simulations expose Analysis and Part Models to a set of sequential inputs in order to characterize the performance of a concept. These simulations may or may not incorporate time as an independent variable. They encompass sensitivity analysis, trade space exploration and performance envelope characterization.

**Equipment** – A generic term used to refer to hardware at any level-of-assembly from a component up through an integrated system.

**Evaluation Factors** – Factors by which a contractor's proposal will be evaluated to make a contract award.

**Export Control** – U.S. export control laws and regulations, including the International Traffic in Arms Regulations (ITAR), and the Export Administration Regulations (EAR) (see FFS 1825)

**Export Licenses** – Licenses or other approvals from the Department of State or the Department of Commerce related to export of hardware, technical data, or software, or provides technical assistance to a foreign destination or “foreign person” (see NFS 1852.225-70)

**Extensibility** – The potential for a vehicle or system to be adapted or modified to provide additional capabilities.

**Facilities** – Includes vehicle processing facilities, integration facilities, launch pads, mission control centers, launch control centers, control rooms, training, test, checkout, and assembly facilities with associated data processing and communication systems.

**Facility Loading** – The level at which a facility is used. For example, if nominal usage is defined as 40 hours of simulation support per week and 50 hours are required during key periods, facility loading would be 125%. This number is used to determine if a facility is over used and to help determine if an additional facility is needed to accommodate usage demands.

**Facility Systems** – Systems necessary to support the operations of the facility. Examples are facility electrical power, water, pneumatics, cranes, etc. It does not include ground support equipment.

**Federate Application** – An application that supports the High Level Architecture (HLA) interface to a runtime infrastructure (RTI) and that is capable of joining a federation execution. A federate application may join the same federation execution multiple times or may join multiple federation executions. However, each time a federate application joins a federation execution, it is creating a new joined federate.

**Federate** – An application that may be or is currently coupled with other software applications under a Federation Object Model Document Data (FDD) and a runtime infrastructure (RTI).

**Federation** – A named set of federate applications and a common Federation Object Model that are used as a whole to achieve some specific objective.

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**Federation Execution** – The actual operation, over time, of a set of joined federates that are interconnected by a runtime infrastructure (RTI).

**Federation Object Model (FOM)** – A specification defining the information exchanged at runtime to achieve a given set of federation objectives. This includes object classes, object class attributes, interaction classes, interaction parameters, and other relevant information.

**Federation Object Model (FOM) Document Data (FDD)** – The data and information in an FOM document that is used by the Create Federation Execution service to initialize a newly created federation execution.

**Fit Checks** – An engineering test, where hardware that is to be installed on a future mission, is brought together on the ground and structural interfaces are verified by physically mating the hardware.

**Flight Controller** – A mission operations team member that supports the CEV vehicle and flight crew anytime from pre-launch through vehicle recovery. A flight controller has a specified discipline of responsibility and a console from which he/she supports the flight operations.

**Flight Design & Analysis** – The activities performed to design the vehicle flight trajectory, mass properties profile, consumables profiles, and other parameters to execute all phases of the mission without violating any hardware, software, or operational constraints.

**Flight Operations Execution** – Activities associated with the plans, processes, and schedules required for the integrated test and operational flight execution. This encompasses real-time support for all phases and aspects of mission and crew operations beginning with pre-launch activities through post-landing egress of the flight crew.

**Flight Operations Products** – Documents and analyses used for flight preparation and execution.

**Flight Planning** – The process of developing a detailed mission flight plan that satisfies all mission requirements. The requirements are integrated into a single plan for ground and crew execution which includes flight design requirements, vehicle operational constraints (thermal conditioning, communications, attitude maneuvers, antenna pointing etc), crew scheduling constraints and payload requirements.

**Flight Readiness Review (FRR)** – The FRR examines tests, demonstrations, analyses, and audits that determine the system's readiness for a safe and successful launch and for subsequent flight operations. It also ensures that all flight and ground hardware, software, personnel, and procedures are operationally ready.

**Flight Rules** – A collection of preplanned decisions to minimize the amount of real-time rationalization required for nominal and off-nominal situations affecting the mission or vehicle during a flight.

**Functional Tests** – Operating tests that confirm that a particular hardware or software item functions in a way that will permit it to meet allocated requirements.

**Ground Planning** – The preparation activities for ground processing and launch operations.

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**Ground Processing** – The activities performed to prepare the personnel, ground systems and flight vehicles during preflight and post-flight operations.

**Ground Systems** – The facilities and facilities systems, ground support equipment hardware and software which are required to support integrated test and operational flights. The ground systems include those needed for ground operations, and flight operations.

**Ground System Operations** – The operation of facilities, facility systems, ground support equipment, and associated software when the flight hardware is not present. These operations typically include validation of ground systems, preventative maintenance, and post-launch refurbishment operations. Also, includes the operation of training systems, whether for system maintenance and validation, or for use to certify/train Flight and Ground Operations personnel. For operations of Ground Systems when flight hardware is involved, see Ground Operations.

**Ground Tests** – Any test performed on system elements or the complete system that does not involve flight. Ground testing includes development, functional, integration, qualification, acceptance, pre-flight, and flight-worthiness tests.

**Guidance Document** – A document that the Contractor will use as guidance in developing a Data Requirements Document (DRD) or a subsystem.

**Guidance and Control** – The process of directing the movements of a space vehicle, including selection of a flight path and making changes in attitude and speed.

**Habitable Volume** – Free, pressurized volume, excluding the space required for equipment, fixtures, and stowage.

**Habitation** – The provision for and management of the crew environment (i.e., through the use of life support systems, thermal control, etc.) in a crewed vehicle or habitat.

**Hardware-in-the-loop (HWIL) Tests** – Tests conducted with hardware under test, where a simulation forms part of the test support equipment.

**High-fidelity, Time-stepped Simulations** – High-fidelity, Time-stepped Simulations accomplish much the same goals as a Desktop Discrete Event Simulation, but utilize HLA as a higher fidelity implementation. The High-fidelity, Time-stepped Simulations simulate system performance at least as fast as real-time.

**Integrated Collaborative Environment (ICE)** – The primary means of sharing, reporting, collecting, recording and accessing program information between NASA, CEV Contractor, major/critical subcontractors and authorized U.S. Government personnel connected with the Constellation Program and Projects. ICE provides real-time collaborative access to a single source of management information, product information and technical data. ICE is the principal mechanism for integrating a “program” digital information management environment.

**Integrated Master Schedule (IMS)** – The IMS is an integrated, master schedule containing the networked, detailed tasks necessary to support the events, accomplishments, and criteria of the IMP. The IMS shall contain all of the contract IMP events, accomplishments, and criteria from contract award to completion of the contract. The IMS shall be a logical network-based schedule that correlates to the program WBS, and is vertically and horizontally traceable to the



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cost/schedule reporting instrument used to address variances (such as Cost Performance Report (CPR) and 533 Cost Reporting (533M/533Q)).

**Integrated Operations** – The activities that involve the spacecraft and other flight elements or the resources of multiple organizations.

**Integrated Product and Process Development (IPPD)** – A management technique that simultaneously integrates all essential product development activities through the use of multi-disciplinary teams to optimize design, manufacturing and supportability processes. It is a systematic approach to the integrated, concurrent design of products and related processes, including manufacturing and support. IPPD is intended to cause designers and developers to consider all relevant life-cycle elements during the initial and early phases of technology or product development.

**Integration Tests** – Tests conducted to verify functional performance has been achieved after hardware and/or software items are assembled and interfaces activated.

**Item Tests** – Tests at the component or item level (i.e., the lowest element of the system that is serialized or otherwise tracked).

**Joined Federate** – A member of a federation execution, actualized by a federate application invoking the Join Federation Execution service as prescribed in IEEE Std 1516.1-2000.

**Large-scale System Simulations** – A Large-scale System Simulation predicts the performance of multiple concept entities during multiple mission segments. This type of simulation predicts interactions between concept entities and their environment by incorporating the concept elements as well as external elements.

**Launch Operations** – The final activities to prepare the ground systems and the integrated vehicle for launch, and the launch of the integrated stack.

**Life Cycle Cost** – See J-5 Appendix 1.

**Logistics Support** – An approach that enables disciplined, unified and iterative management of support considerations into system and equipment design. Logistics support includes development of support requirements that are related to readiness objectives, to design, and to each other. Requirements in turn drive acquisition of required support; logistics support is then employed during the operational phase.

**Mass Properties** – The distribution of mass within the component, subsystem, system, or vehicle, which can change throughout the mission due to consumables usage and the transfer of hardware. The vehicle mass properties are tracked and managed to avoid adverse impacts to the vehicle's control characteristics.

**Micrometeoroid and Orbital Debris (MMOD) Penetration** – MMOD damage causing loss of a critical function or string of functional redundancy that would lead to loss of vehicle or would lead to loss of crew.

**Mission Control Centers** – The central command and control facility for Mission Operations.

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**Mission Operations** – The activities performed to plan, direct, manage, and execute the flight by the mission control management, flight controllers, and support organizations. A subset of the Flight Operations Execution that begins at liftoff and ends with crew egress after landing.

**Mission Segment Simulation** – A Mission Segment Simulation varies the inputs to Analysis and Part Models in accordance with an anticipated portion of the concept mission. Time is the independent variable in a Mission Segment Simulation. Mission Segment Simulations incorporate as many Analysis and Part Models as is needed to predict the total performance of a concept during a segment of the anticipated mission. These models are exposed to input sets that represent events as a function of time.

**Mockups** – A training system or other facility with a physical similarity to flight or ground systems hardware for the purpose of training, engineering evaluations, or other studies.

**Module** – A self-contained unit of a spacecraft that performs a specific task or class of tasks in support of the major function of the craft (e.g., SM, CM, LAS).

**Nominal Operational Scenarios** – Cases that describe situations that are within the planned capabilities of the vehicle (example, CEV docking with the lander across a range of lunar altitudes.)

**Non-operating Environment Tests** – Tests in environments (shock, vibration, acoustic, and temperature) while the hardware is not in an operating mode (i.e., without power, mechanical, or propulsion systems in operation). Environmental tests on non-operational hardware (i.e., without power, mechanical, or propulsion systems in operation) that is outside the normal operating environment of the subject hardware (i.e. temperature extremes experienced by berthing system during Earth Orbit to Destination Vicinity Phase).

**Non Operational Environment** – The environment (ground transportation, etc.) in which the vehicle will be exposed to when it is not intended to be operational.

**Off-Nominal Operations Scenarios** – Cases that describe situations that are outside the planned operations (example, inability to dock lander to CEV, resulting in a need to perform an EVA to re-enter the CEV).

**Open System Architecture** – A system with common interfaces that facilitate products from multiple vendors to operate on.

**Operating Conditions & Environment Tests** – Tests of the flight and support assemblies in each operating mode and in the maximum (worst case) predicted operating and environmental conditions.

**Operational Constraint** – A limit on the operation of equipment that avoids hazards, precludes damage or excessive degradation, and observes the certified limits of the equipment.

**Operational Environment** – The environment (thermal, pressure, radiation, etc.) in which the vehicle is intended to be operated.

**Operational Flights** – The activity phase occurring after the design, development, test, transition and deployment of the Exploration System to Space Operations Mission Directorate for the purposes of space exploration and pursuing the Vision.

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**Operational Interfaces** – Formal organizational and personnel interactions required to implement contract responsibilities and the necessary interfaces to fully integrate and coordinate activities internal and external to the CEV program.

**Operations** – The processes, plans, system requirements, procedures, and work to be performed associated with the preparation, launch and flight execution, and recovery of the CEV. The scope of Operations concern the activities with equipment once it has been delivered to the government and are in support of the integrated test and operational flights. This is applicable to all types of operations.

**Part Models** – A Part Model describes a function-performing component or system. In its most fundamental form, a part model describes the geometry of the part, component or system in question. Early in the design process, a part model may be a crudely defined vehicle sub-system. As concept development progresses, fidelity is added regarding the characteristics and performance of the part. The difference between a Part Model and an Analysis Model is that a Part Model tracks all discipline parameters that are relevant to a particular part/component, while an Analysis Model can be executed to determine the performance of several components for a particular discipline or group of disciplines.

**Part Task Trainers** – Facilities and equipment that are highly specialized and serve to train a specific subset of a larger system.

**Past Performance** – The initiative to gather (and use in future source selection) factual information about the performance of a contractor against the performance requirements in the contract.

**Post Landing Operations** – The activities required to plan, deploy, prepare the landing sites and landing aids for the flight vehicle, aid crew egress and transport, perform medical/emergency operations, safe flight hardware, and transport/retrieve appropriate parts of the flight system.

**Preflight Operations** – All the activities performed prior to liftoff of the vehicle. Includes ground processing, training, flight design, analysis, planning and launch operations.

**Preliminary Design Review (PDR)** – The PDR demonstrates that the preliminary design meets all system requirements with acceptable risk. It shows that the correct design option has been selected, interfaces identified, and verifications methods have been satisfactorily described. It also establishes the basis for proceeding with detailed design.

**Probabilistic Risk Assessment** – A set of methodologies employed to determine quantitative probability a given end state or states (e.g., Loss of Mission, Loss of Crew) will occur. Probabilistic Risk Assessment results can be used to develop or validate Fault Trees and Failure Modes analysis. They also can be used as a tool for making design and logistics decisions.

**Procedure** – Set of detailed instructions used by the crew, ground operations and flight operations personnel to assess status, reconfigure, operate, trouble-shoot, safe, and maintain CEV systems under both nominal and off-nominal conditions. The procedures may also be executed by spacecraft executor software to fulfill specific tasks.

**Process Integrity Metrics** – A measurement of how well a process is meeting its intended goal.

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**Qualification** – The activity that proves design, manufacturing, and assembly have resulted in hardware/software that conforms to design and performance requirements during or after exposure to specific environmental conditions. The qualification activity consists of various tests, analyses, demonstrations, and inspections as required to verify conformance of design to specified requirements.

**Qualification Margin** – An increase in the tested, demonstrated, or analyzed conditions beyond the most severe occurrence expected during the service life (including acceptance testing) in order to show sufficient robustness in the design. A qualification margin may be an increase in operating or non-operating level, range, cycles or duration of exposure to environmental conditions (such as temperature or vibration) or parameters (such as voltage, current, load, or torque). Qualification margin requirements are intended to achieve robustness for:

- Tolerance of the unit to unit differences in flight articles and the qualification article due to allowed or expected variations in parts, manufacturing tolerances, material properties, and manufacturing processes.
- Immunity to degradation such as fatigue, wear, loss of properties, or functionality after experiencing a specified maximum amount of acceptance testing and operational usage.

**Qualification Tests** – Formal tests conducted with defined qualification margin as part of the certification program to qualify a design, manufacturing process, and acceptance testing program to produce equipment able to accomplish the full range of performance requirements in all predicted operating and non-operating service life environments (including acceptance testing).

**Real-Time Support** – Level of support that has the personnel, tools, and locale necessary to provide immediate response.

**Risk** – The uncertainty of attaining a performance outcome or result and is the function of the probability and the consequence of failing to attain the performance outcome or result.

**Risk Management (RM)** – The processes for identifying, assessing, mitigating, and tracking risks.

**Runtime Infrastructure (RTI)** – The software that provides common interface services during a High Level Architecture (HLA) federation execution for synchronization and data exchange.

**Safety-Critical Software** – Software is safety-critical if it meets at least one of the following criteria:

1. Resides in a safety-critical system (as determined by a hazard analysis AND at least one of the following:
  - a. Causes or contributes to a hazard.
  - b. Provides control or mitigation for hazards.
  - c. Controls safety-critical functions.
  - d. Processes safety-critical commands or data.
  - e. Detects and reports, or takes corrective action, if system reaches hazardous state.
  - f. Mitigates damage if a hazard occurs.
  - g. Resides on the same system (processor) as safety-critical software.

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2. Processes data or analyzes trends that lead directly to safety decisions (e.g., determining when to turn power off to a wind tunnel to prevent system destruction.)
3. Provides full or partial verification or validation of safety-critical systems, including hardware or software subsystems.

**Service Life** – The life of an equipment item starting at the completion of fabrication and continuing through all levels of acceptance testing, handling, transportation, storage, pre-launch processing, all phases of flight (launch, on-orbit, descent, landing), rework/refurbishment, retest, and reuse as required or specified.

**Simulator** – A training system or facility that generates conditions approximating actual or operational conditions to a level commensurate with the function it is supporting (e.g. training, testing, engineering evaluation).

**Software** – Computer programs, procedures, rules, and associated documentation and data pertaining to the development and operation of a computer system. Software includes programs and operational data. This also includes Commercial-Off-The-Shelf, Government-Off-The-Shelf, Military-Off-The-Shelf, reuse, auto code generated, firmware, and open source software components.

**Software Requirements Review (SwRR)** – A requirements review that decomposes the subsystem requirements into lower level flight and ground software requirements, which are documented in a series of Software Requirements Specifications (SRSs).

**Standalone Operations** – The activities that involve a single flight element.

**Statement of Work (SOW)** – A document that expresses the tasks to be performed by the contractor.

**Subsystem** – A system that is part of some larger system. A spacecraft is first broken up into modules (if needed), then into subsystems, and finally into components.

**Sustaining Engineering** – Long term design engineering responsibilities and support associated with Operational flights.

**System** – A set or arrangement of interdependent elements/segments that are used to accomplish mission objective(s). Exploration systems are Crew Transportation, Cargo Delivery, In-Space Support, Destination Surface, Robotic Precursor System, and Ground Support. These Systems comprise the Exploration System of Systems.

**System Architecture Model** – The combination and coupling of Analysis Model and Part Model results is one form of a System Architecture Model. It not only defines the complete physical and functional configuration, but it also defines composite performance and characteristics of the system or architecture. A System Architecture Model contains analysis models that are used to assess performance parameters. It can be thought of as everything that can be driven, visualized and observed in a large-scale system simulation. A second form of a System Architecture Model is a high-level, functional description of a system that may at a later date consist of Part and Analysis Models. System Architecture Models represents vehicle function, structure and behavior in the form of function and component hierarchies, functional allocations, process flow diagrams and dynamic models.

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**System Definition Review (SDR)** – The SDR examines the proposed system architecture/design and the flowdown to all functional elements of the system.

**System Engineering & Integration (SE&I)** – The technical and management efforts for directing and controlling the integrated engineering effort for the System.

**System Engineering, Integration & Test (SEI&T)** – The design, development, integration, and test of large and complex systems, where a system is understood to be an assembly or combination of interrelated elements or parts working together toward a common objective.

**Systems Management Software** – The subset of flight software performing integrated health management (including automated vehicle-level fault detection, isolation and recovery, troubleshooting, and prognostication), onboard resource management (including management of redundancy, power, data, thermal, and other finite items), and autonomous operations support. These disciplines provide the coordination of intersystem interactions, management of intersystem dependencies, monitoring of critical resources, a caution and warning data synthesis and identification capability, sequencing between distinct operational phases or system modes, and assisting the vehicle/crew in overcoming anomalies.

**Technical Performance Parameters (TPP)** – Technical Performance Parameters are identified by the CEV Program Manager for monitoring during the design and development, such as margins for Mass Properties, Power Allocation, Volume, CPU Utilization, Bandwidth/Throughput.

**Technology Readiness Level (TRL)** – A systematic metric/measurement system that supports assessments of the maturity of a particular technology and the consistent comparison of maturity between different types of technology.

TRL 1: Basic principles observed and reported

TRL 2: Technology concept and/or application formulated

TRL 3: Analytical and experimental critical function and/or characteristic proof-of-concept

TRL 4: Component and/or breadboard validation in laboratory environment

TRL 5: Component and/or breadboard validation in relevant environment

TRL 6: System/subsystem model or prototype demonstration in a relevant environment (ground or space)

TRL 7: System prototype demonstration in a space environment

TRL 8: Actual system completed and “flight qualified” through test and demonstration (ground or space)

TRL 9: Actual system “flight proven” through successful mission operations

**Test-qualified Hardware/Software** – Hardware/Software used to support testing of other hardware/software that is of sufficient fidelity and validation to conduct a valid test of the hardware/software being tested.

**Timeline** – A sequential series of events that describe the CEV operation. A timeline can represent the vehicles mission at different levels of detail (ex. overview, summary and detailed timelines). The timeline includes information on trajectory events and scheduled crew activities as well as associated ground activities.

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**Training Systems** – The hardware, software, and facilities required to educate, test, certify, qualify, standardize, maintain proficiency, and otherwise prepare the crew, ground and flight operations personnel for successful execution of Exploration missions.

**Transition** – The handover of the CEV's operation, hardware and software responsibilities from the combined developing contractor team and NASA Exploration Space Mission Directorate to the NASA Space Operations Mission Directorate's operations, engineering and management teams.

**Unit Testing** – The testing of individual hardware components or software components (CSUs) to ensure that they operate correctly.

**Validation<sup>1</sup>** – Assessment of a set of requirements demonstrating that the requirements are feasible within allowable means (cost/schedule/technical capability), are verifiable, and if fully met, will produce a product that accomplishes the intended objectives.

**Validation<sup>2</sup>** – Proof that the product accomplishes the intended purpose. May be determined by a combination of test, analysis, and demonstration.

**Vehicle Motion/Flight Simulations** – A vehicle motion simulation couples a large-scale simulation to physical hardware. This typically consists of vehicle and facility interiors with flight controls, access points and sensory cues. These simulations are used to characterize the interaction between human operators and the concept in question.

**Verification** – Proof of compliance with specifications. May be determined by a combination of test, analysis, demonstration, and inspection.

## **Attachment J-5 Appendix 1**

### **Life Cycle Cost Analysis**

The Contractor shall provide estimates of Life Cycle Costs for a lunar-capable Crew Exploration Vehicle (CEV) as described in the Statement of Work (SOW) for all major reviews (e.g., SDR, PDR, CDR) and at each quarterly PMR. In addition to a point estimate for costs, the Contractor shall provide an estimate of the cost range associated with known project risks. The Contractor shall also provide a detailed discussion of the impact of the current design, including the cost impact from key trade studies, design and operations changes since the last review, and the rationale for the changes. The Contractor shall provide cost estimates for the individual CEV variants as outlined in the SOW.

The overall focus of the Life Cycle Cost Analysis will be as vehicle-centric as possible. As an example, the CEV will require a tunnel adapter for docking with the International Space Station (ISS). While this equipment is essential to allowing the CEV to perform its functions in Block I missions, the cost of this tunnel is not included as part of the CEV Life Cycle Cost. NASA will define the vehicle boundaries for the cost estimates that the Contractor is expected to provide. Likewise, NASA will provide a clear definition of any equipment and facilities that will be delivered as Government Furnished Equipment (GFE) or obtained through separate procurements. These definitions are to be provided to the Contractor within 90 days of contract award.

Similarly, in order to provide a common basis for cost comparisons, it is necessary to prescribe a duration for which Life Cycle Costs are to be estimated and analyzed. For the purposes of the aforementioned deliverables, that time period will be begin with ATP for Phase 2 of the CEV contract and continue through 20 years after the first human flight to ISS. For example, if the first flight occurs in 2012, the life cycle cost estimate period would be 2006 through 2032. The Contractor is also expected to provide cost estimates easily traceable to an agreed-upon Work Breakdown Structure (WBS). The Contractor shall provide a CEV System that shall have a lifecycle that ends no less than 20 years after the first human flight to ISS.

Life Cycle Cost, for the purposes of this contract, will cover four major phases:

#### **1. Design, Development, Test, and Evaluation (DDT&E)**

Design, Development, Test, and Evaluation (DDT&E) consists of design and development costs incurred from the beginning of the conceptual phase through the end of the System Development and Demonstration phase. For the purposes of this procurement, DDT&E costs are also to include the first flight unit production costs.

This phase typically includes costs of:

- concept refinement trade studies
- advanced technology development
- system design and integration
- development, fabrication, assembly, and test of hardware and software for prototypes and/or engineering development models
- system test and evaluation
- system engineering and program management
- initial spares and repair parts associated with prototypes and/or engineering development models
- all subcontractor costs necessary to ensure completion of the aforementioned tasks



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Certain tasks and equipment have been identified as areas of NASA core competency. Within these areas, NASA anticipates that the Agency centers will either (a) team with the Contractor on certain developments, with the Contractor taking ownership of the product development at a specified point and ultimately responsibility for the core product or (b) assume all responsibility for design, development, and production of the core product, with the product provided as GFE to the Contractor. We also anticipate that NASA will take responsibility for some advanced technology developments. NASA will provide this information to the Contractor within 90 days of contract award.

**2. Production**

Production includes all costs associated with building and deploying the CEV spacecraft variants from the initial production unit (after the completion of the unit including with DDT&E) through completion of the vehicle fleet. Typical costs include those associated with:

- producing and deploying the primary hardware (the CEV variants)
- system engineering and program management
- spares and repair parts associated with production assets
- operations and maintenance associated with the production activity
- all ongoing costs associated with production of equipment for replacement of expended equipment and refurbishment for reusable vehicles
- all subcontractor costs associated with production of the CEV fleet

NASA will provide the Contractor with a flight manifest for the CEV variants. The Contractor is expected to produce a fleet of vehicles of a size appropriate to support the flight manifest, with minimal delays due to any refurbishment and maintenance. All other vehicles, the CEV Service Module, and certain CEV Crew Module components (e.g., the heat shield) are anticipated to be expendable.

The Contractor will be completely responsible for all costs in this phase.

**3. Operations and Support**

Operations and support consists of costs incurred from the initial flight through the end of system operations and includes all costs of operating, maintaining, and supporting operations for all CEV variants through the specified time period.

This consists of the costs of personnel, equipment, supplies, software, and services associated with operating, modifying, maintaining, supplying, training, and supporting the CEV. Direct and indirect costs are expected to be included in the estimate.

CEV operations will be conducted at key NASA centers, and, as such, operations costs will involve a mix of government and contractor personnel. Similarly, we anticipate that other contractors will be responsible for key elements needed to assure CEV mission success, e.g., the Crew Launch Vehicle (CLV). As with all CEV costs, NASA will provide the Contractor with a clear idea of its role with regard to CEV operations and the cost estimates that the Contractor will be responsible to provide as part of the Life Cycle Cost.

**4. Upgrade for Commencement of Lunar Operations**

There will be a gap of several years between the time of initial CEV launch and the time at which other lunar elements will be completed and ready for launch.

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It is anticipated that the CEV will require some modest upgrades prior to the commencement of actual lunar operations. We anticipate that these costs will include, but not be limited to:

- upgrade of equipment to replace worn or obsolete systems
- upgrades to maximize commonality with lunar elements

We anticipate that the Contractor will be completely responsible for all costs in this phase. As such, the Contractor is required to state their assumptions about what upgrades and replacements are anticipated for upgrading CEV prior to commencement of lunar operations. These assumptions shall serve as the basis for this portion of the Life Cycle Cost analysis. If these upgrades are anticipated to require involvement of NASA centers, such as possible advance technology work, we expect the Contractor to note this during reviews and a solution will be negotiated.

## **ATTACHMENT J-6**

### **SAFETY AND HEALTH PLAN**

**ATTACHMENT J-7**

**AWARD FEE EVALUATION PLAN  
CREW EXPLORATION VEHICLE  
Contract NNJ06TA25C  
Schedule A**

## **I. INTRODUCTION**

In accordance with the provisions of the Federal Acquisition Regulation (FAR), and NASA and JSC policies, a performance evaluation procedure is hereby established for determination of award fees payable under this contract. The award fee is designed to provide economic motivation for the Contractor to provide timely, high quality outputs that exceed the minimum requirements of the contract. The intent of this plan is to set up procedures for evaluation of Contractor performance using existing data and systems to the maximum extent while imposing minimum administrative burden on the Government and Contractor. The payment of any award fee is contingent upon compliance with contractual requirements and performance to the degree specified below.

This contract is a hybrid contract consisting of three schedules, Schedules A, B, and C. Award fee evaluation for Schedules A and C are covered by attachments J-7 and J-17, respectively. Schedule B contains separate incentives specific to that contract schedule, and is not subject to award fee provisions.

The Contractor's interim performance under Schedule A will be evaluated by NASA at the expiration of each period specified in Enclosure II, Performance Milestones. The evaluation to be performed by NASA will be based on NASA's assessment of the Contractor's accomplishment of the various areas of work covered by the Statement of Work, in accordance with the factors, weightings, procedures, and other provisions set forth below.

The amount of available Award Fee in each period is subject to equitable adjustments arising from changes or other contract modifications. The amount of the Award Fee to be paid is determined by the Government's evaluation of the Contractor's performance in terms of the criteria stated in the contract. This determination and the methodology for determining the Award Fee are unilateral decisions made solely at the discretion of the Government. The Government may unilaterally change any areas of this plan not otherwise requiring mutual agreement under the contract. Such changes will be made prior to the beginning of an evaluation period to which the changes apply by timely notice to the Contractor in writing. The Contractor will be informed of any changes to the evaluation criteria or the weightings prior to the affected Award Fee period.

Each award fee evaluation, with the exception of the last evaluation, will be an interim evaluation and the corresponding fee payment is provisional only. All interim evaluations and provisional fee payments will be superseded by the final evaluation and fee determination for Schedule A.

## **II. ORGANIZATIONAL STRUCTURE**

### **A. Performance Evaluation Board Integration Team (PEB-IT)**

The PEB-IT will be composed of selected NASA technical and administrative personnel and headed by the Contracting Officer's Technical Representative (COTR). The COTR will be the focal point for the accumulation and development of Award Fee evaluation reports, reviews, and presentations, as well as discussions with Contractor management on Award Fee matters. The PEB-IT will evaluate the Contractor's performance as related to the criteria listed in paragraph III below.

The PEB-IT will furnish the Contractor performance evaluations at the midpoint of the interim period. The purpose of these communications is to discuss any specific areas where the Contractor has excelled and areas where future improvement is necessary.

The PEB-IT will prepare an evaluation report for review by the PEB for each evaluation period. This report will include a recommendation to the PEB as to the adjective rating and numerical score (Enclosure 1) to be assigned for the Contractor's performance for the period evaluated.

### **B. Performance Evaluation Board (PEB)**

The Performance Evaluation Board (PEB) will be comprised of selected technical and administrative personnel of NASA. The PEB will assess the Contractor's performance after each evaluation period to determine whether, and to what extent, the Contractor's performance during the evaluation period (milestone) is deserving of the interim payment of Award Fee. The PEB, at the end of each evaluation period, will consider the PEB-IT report (PEBR) and prepare a summary of the evaluations for review by the Fee Determination Official (FDO). This summary will include a recommendation to the FDO as to the adjective rating and numerical score to be assigned for the Contractor's performance in the preceding evaluation period.

### **C. Fee Determination Official**

A senior NASA official will be the FDO. After considering available pertinent information and recommendations, the FDO will make an interim performance determination for each period in accordance with the provisions of this Attachment J-7 and G.3 "Award Fee for End Item contracts" per the applicable schedule. The same process will be followed for the final performance evaluation period except the determination will be final as defined by the clause.

The FDO will consider the recommendation of the PEB, PEB-IT Report, information provided by the Contractor, if any, and any other pertinent information in determining the performance score. The FDO's determination of the score will be stated in a written Award Fee Determination and will be provided to the Contractor by the Contracting Officer within 45 calendar days after the end of the evaluation period.

## **III. EVALUATION PROCEDURES**

### **Award Fee Periods**

#### **Schedule "A" DDT&E**

NASA will evaluate this contract schedule in accordance with the clause NFS 1852.216-77, Award Fee For End Item Contracts. Each award fee period will be based on objective project milestones identified in this plan and contract schedule. Each interim award fee period and provisional payment is based on the Contractor's successful completion of the milestone(s) agreed to and as identified in the Contractor's Integrated Master Schedule (IMS). The award fee distribution table contained in Enclosure II, Performance

Milestones, provides a list of performance milestones and available provisional fee for each milestone. In accordance with NFS 1852.216-77, all award fee evaluations, with the exception of the last evaluation, will be interim evaluations.

#### **Objective and Subjective Criteria**

No later than 30 calendar days prior to the start of each interim Award Fee evaluation period (milestone), the Contractor may submit to the Contracting Officer recommended objective performance metrics, weightings, and Areas of Emphasis (AOE) for consideration by NASA to be used for the ensuing evaluation period.

NASA will establish performance metrics and AOE for each evaluation period (milestone) and communicate these to the Contractor at least 15 calendar days prior to the start of each evaluation period. NASA may unilaterally change the weightings of the criteria from period to period. However, cost control will be weighted at no less than 25 percent.

#### **Contractor Self Evaluation and Submissions**

The Contractor shall furnish a self-evaluation for each evaluation period. The self-evaluation must be received by the Contracting Officer 5-working days prior to the end of the period and shall be limited to no more than 20 pages.

The Contractor will be furnished a copy of the PEB's findings, conclusions, and fee recommendation. The Contractor will be afforded the opportunity to submit for consideration of the FDO: (a) proposed evaluations or conclusions or (b) exceptions to the evaluations, conclusions, or fee recommendations of the PEB; and (c) supporting reasons for such exceptions or proposed evaluations or conclusions. The Contractor's submissions must be made in writing and must be submitted through the Contracting Officer to the FDO within 5-working days from the date of the Contractor's receipt of the PEB findings. If the Contractor does not provide additional information to the Contracting Officer within the time stated above NASA will conclude that the Contractor concurs with the evaluation and recommended score.

In the event the FDO has not received a submission from the Contractor, the performance determination will not be executed until expiration of the 5-working day period prescribed above for Contractor submission. The Contractor may waive the 5-working day waiting period by providing a written statement that no response will be submitted.

The Contractor shall submit to the Contracting Officer a Corrective Action Plan (CAP) for any weaknesses or failing objective performance areas identified by NASA as part of the evaluation. The CAP should include a description of the non-conformance, determination of the root cause of the non-conformance, action required to correct the weakness and prevent recurrences, and the schedule for completion of the action. The CAP shall be submitted to the Contracting Officer within 30 calendar days after receipt of the each interim performance determination for the evaluation period. Corrective Actions will be closed by concurrence from the Contracting Officer and the COTR. Failure to submit a CAP within the timeframe stated above will result in a weakness in the next evaluation period.

#### **IV. EVALUATION CRITERIA AND WEIGHTINGS**

NASA will use the following subjective factors as a basis for arriving at the interim and final award fee score:

<u>Award Fee Evaluation Criteria</u>	<u>Weight</u>
Technical	45%
Program Management	20%
Cost	25%
Small Business/Small Disadvantaged Business	10%

**Crew Exploration Vehicle – (CEV)****Subcontracting Goals****A. Technical (45%)**

This factor will include an evaluation of the Contractor's performance in all areas of Technical performance, both interim and final. This includes:

- i. Safety and mission assurance,
- ii. Requirements definition and flow down,
- iii. Risk management,
- iv. Margin management, and
- v. Innovation. (Innovation, both here and in Program Management, is defined as innovations that reduce cost, benefit schedule both from a current and future perspective, or result in improved design, coordination, or communication without adverse effects on performance, cost, or schedule.)
- vi. Life Cycle Cost

**B. Program Management (20%)**

This factor will include an evaluation of the Contractor's performance in all areas of Program Management performance, both interim and final. This includes schedule management, subcontract management, responsiveness, innovation, life cycle cost management, and corporate commitment to capital investments and personnel. (Corporate commitment to personnel includes the quantity and quality of personnel assigned to the CEV Phase 2 contract. Quantity includes ramp-up and retention of qualified personnel at adequate levels to meet schedule, cost and performance objectives. Quality of personnel will be evaluated on the Contractor's success in maintaining and replacing key personnel within the CEV Phase 2 contract.)

**C. Cost Management (25%)**

This factor will include an evaluation of the Contractor's cost performance under the contract. Earned Value Management System data, cost performance reports and other cost data sources will be used in the Cost Management assessment for this factor. Cost performance will be assessed by evaluating the cost expended on the actual work performed during the period being evaluated, including quantitative assessment of the award fee period cumulative Cost Performance Index (CPI). In addition, a qualitative assessment of appropriate earned value variances, cost implications of the Schedule Performance Index (SPI), and other period-specific cost management trend data will be considered.

**D. Small Business/Small Disadvantaged Business Subcontracting Goals (10%)**

The Contractor's performance will be evaluated against the contract goals for small/small disadvantaged business subcontracting.

**V. SCORING**

**The percentage of award fee to be paid for a period is equal to the numerical score assigned.** In accordance with the Section G clause for award fee, no award fee will be paid when Contractor performance is determined to be Poor/Unsatisfactory.

An overall performance evaluation and fee determination of zero shall be made for any evaluation period when there is a major breach of safety or security as defined in NFS 1852.223-75, Major Breach of Safety or Security.

**VI. LIST OF ENCLOSURES**

- Enclosure I: Numerical Ranges and Adjective Definitions  
Enclosure II: Performance Milestones



**Enclosure I**

**Numerical Ranges and Adjective Definitions**

This enclosure sets forth the adjective ratings, definitions, and associated numerical ranges to be used to define the various levels of performance under the contract.

ADJECTIVE RATING	RANGE OF POINTS	DESCRIPTION
Excellent	100 - 91	Of exceptional merit; exemplary performance in a timely, efficient and economical manner; very minor (if any) deficiencies with no adverse effect on overall performance.
Very Good	90 - 81	Very effective performance, fully responsive to contract; contract requirements accomplished in a timely, efficient and economical manner for the most part; only minor deficiencies.
Good	80 - 71	Effective performance; fully responsive to contract requirements; reportable deficiencies, but with little identifiable effect on overall performance.
Satisfactory	70 - 61	Meets or slightly exceeds minimum acceptable standards; adequate results; reportable deficiencies with identifiable, but not substantial, effects on overall performance.
Poor/Unsatisfactory	60 - 0	Does not meet minimum acceptable standards in one or more areas; remedial action required in one or more areas; deficiencies in one or more areas which adversely affect overall performance.

**Enclosure II****Performance Milestones**

Performance Milestones will be established prior to contract award. These milestones will be used as measurements of performance in accordance with the Award Fee for End Item Contracts.

**AWARD FEE DISTRIBUTION**

Period/Milestone	Evaluation Period Schedule	Available Fee	Earned Fee

## **ATTACHMENT J-8**

### **SMALL BUSINESS SUBCONTRACTING PLAN**

**INDIVIDUAL  
SUBCONTRACTING PLAN  
FOR SMALL BUSINESS CONCERNS**

**LOCKHEED MARTIN PROPRIETARY INFORMATION**

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Attachment J-9

Crew Exploration Vehicle – (CEV)

**ATTACHMENT J-9**

**DELIVERABLE ITEMS LIST**

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Attachment J-9

Crew Exploration Vehicle – (CEV)

**ATTACHMENT J-9**  
**DELIVERABLES ITEMS LIST**

The Deliverable Items List (Attachment J-9) contains all deliverables described in the Statement of Work (SOW), excluding the DRDs listed in Attachment J-2, Data Procurement Document and the date each deliverable is scheduled. This list includes contractor deliverables, including the Ground Support Equipment to be delivered in support of spacecraft processing, launch and recovery.

Lockheed Martin has defined deliverable item as, an item which, upon delivery, accountability is transferred to NASA. Each delivery will be accompanied by the appropriate transmittal documentation (i.e.: DD250 Form, Certificate of Completion/Compliance (COC), Letter of Transmittal).

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Attachment J-10

Crew Exploration Vehicle – (CEV)

**ATTACHMENT J-10**

**List of Installation Accountable Property and Services**

**ATTACHMENT J-11**

**GOVERNMENT FURNISHED PROPERTY LIST**



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Crew Exploration Vehicle – (CEV)

Attachment J-12

**ATTACHMENT J-12**

**LIST OF GOVERNMENT FACILITIES**

## **ATTACHMENT J-13**

### **ACRONYM LIST**

Acronym List

AC	Alternating Current
ACI	Administratively Controlled Information
ACO	Administrative Contracting Officer
ACWP	Actual Cost of Work Performed
ADD	Architectural Design Document
ADP	Acceptance Data Package
AFFARS	Air Force Federal Acquisition Regulation Supplement
AFLC	Air Force Logistics Command
AFMC	Air Force Material Command
AFMCFARS	Air Force Material Command Federal Acquisition Regulation Supplement
AIAA	American Institute of Aeronautics and Astronautics
AIS	Automated Information Systems
ALARA	As Low As Reasonably Achievable
AM	Ames
AML	Approved Materials List
AMT	Architectural Modeling Tool
ANSI	American National Standards Institute
AOE	Areas of Emphasis
APAS	Androgynous Peripheral Assembly System
APL	Approved Processes List
AR	Acceptance Review
AS	Aerospace Standards
ASAP	Aerospace Safety Advisory Panel
ASCII	American Standard Code for Information Interchange
ASRS	Automated Support Requirements System
ATB	Abort Test Booster
ATCS	Active Thermal Control Systems
ATP	Authority To Proceed
ATP	Acceptance Test Procedure
AWG	American Wire Gauge
BAFO	Best And Final Offer
BCWP	Budgeted Cost for Work Performed
BCWS	Budgeted Cost for Work Scheduled
BIS	Bureau of Industry and Security
BIT	Built-In Test
BITE	Built-In Test Equipment
BOE	Basis Of Estimate
C&DH	Command & Data Handling
C&T	Communications & Tracking
CAD	Computer Aided Design
CAGE	Commercial And Government Entity
CAIL	CEV Avionics Integration Laboratory

## Crew Exploration Vehicle – (CEV)

CAIV	Cost As an Independent Variable
CAOT	Cognizant Audit Office Template
CAP	Corrective Action Plan
CARD	Cost Analysis Requirements Description
CAS	Cost Accounting Standards
CASB	Cost Accounting Standards Board
CBI	Confidential Business Information
CBL	Commercial Bill of Lading
CBT	Computer Based Training
CCAS	Cape Canaveral Air Station
CCAFS	Cape Canaveral Air Force Station
CCCI or C3I	Command, Control, Communications and Information
CCDR	Contractor Cost Data Reporting
CCF	Common Cause Failure
CCIP	Contamination Control and Implementation Plan
CCP	Contamination Control Plan
CCRM	Continuous Cost Risk Management
CCS	Center Chief of Security
CCSDS	Consultative Committee on Space Data Standards
CD	Compact Disk
CDF	Cumulative Distribution Function
CDM	Configuration and Data Management
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CDS	Cargo Delivery System
CECSR	Contractor's Employee Compensation System Review
CESR	Contractor's Estimating System Review
CEV	Crew Exploration Vehicle
CEVLV	CEV Launch Vehicle
CEVPO	Crew Exploration Vehicle Project Office
CFD	Computational Fluid Dynamics
CFR	Code of Federal Regulations
CFSR	Contract Fund Status Report
CG	Center of Gravity
CIL	Critical Items List
CIO	Chief Information Officer
CIS	CEV Instrumentation System
CLIN	Contract Line Item Number
CLV	Crew Launch Vehicle
CM	Configuration Management
CM	Crew Module
CMG	Control Moment Gyro
CMM	Capability Maturity Model
CMMI	Capability Maturity Model – Integrated

CMP	Configuration Management Plan
CO	Contracting Officer
CoFR	Certificate of Flight Readiness
COMSEC	Communications Security
CONOPS	Concept of Operations
COTR	Contracting Officers Technical Representative
COTS	Commercial-Off-The-Shelf
CPAF	Cost Plus Award Fee
CPARS	Contractor Performance Assessment Reporting Systems
CPI	Cost Performance Index
CPIA	Chemical Propulsion Information Agency
CPIC	Capitol Planning & Investment Control
CPIF	Cost Plus Incentive Fee
CPR	Cost Performance Report
CPSR	Contractor's Procurement System Review
CPU	Central Processing Unit
CSC	Computer Software Component
CSCI	Computer Software Configuration Item
CSP	Cryptographic Security Plan
CSS	Common Support Services
CST	Central Standard Time
CST	Cost/Price Summary Template
CST WBS	Cost/Price Summary Template Work Breakdown Structure
CSU	Computer Software Unit
CWBS	Contractor Work Breakdown Structure
CXP	Constellation Program
CY	Contract Year
D&C	Displays & Controls
DAL	Data Accession List
DC	Direct Current
D. C.	District of Columbia
DCMC	Defense Contract Management Command
DCAA	Defense Contract Audit Agency
DDT&E	Design, Development, Test & Evaluation
DFAR	Defense Federal Acquisition Regulation Supplement
DFRC	Dryden Flight Research Center
DID	Data Item Descriptions
DIEP	Display and Interface Evaluation Plan
DL	Direct Labor
DM	Data Management
DoD	Department of Defense
DOE	Department of Energy
DOORS	Dynamic Object Oriented Requirements System
DPD	Data Procurement Document

DR	Dryden
DRD	Data Requirements Document
DRM	Design Reference Mission
DSI	Data Source Information
DSN	Deep Space Network
DUNS	Dun and Bradstreet Number
EAC	Estimate at Completion
EAR	Export Administration Regulations
ECLS	Environmental Control and Life Support
ECLSS	Environmental Control and Life Support System
ECO	Engineering Change Order
ECP	Engineering Change Proposal
EDA	Electronic Data Access
EDCG	Externally Driven Cost Growth
EDI	Electronic Data Interchange
EDS	Earth Departure Stage
EDSG	Externally Driven Schedule Growth
EDU	Engineering Development Unit
EEE	Electrical, Electronic and Electromechanical
EEST	Exploration Electrical power System Testbed
EF	Early Finish
EFFBD	Extended Functional Flow Block Diagrams
EIA	Electronic Industry Alliance
EICD	External Interface Control Document
EIRD	External Interface Requirements Document
ELV	Expendable Launch Vehicle
EMC	Electromagnetic Compatibility
EME	Electromagnetic Effects
EMI	Electromagnetic Interference
EN	Evaluation Notice
EP	Equivalent Personnel
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPDC	Electrical Power Distribution and Control
EPM	Excel Pricing Model
EPS	Electrical Power System
ES	Early Start
ESD	Electrostatic Discharge
ESMD	Exploration Systems Mission Directorate
eSRS	Electronic Subcontracting Reporting Systems
EVA	Extra Vehicular Activity
EVM	Earned Value Management
EVMS	Earned Value Management System
EWR	Eastern-Western Range

## Crew Exploration Vehicle – (CEV)

FA	Failure Analysis
FAA	Federal Aviation Administration
FAR	Federal Acquisition Regulation
FAR	Federal Aviation Regulation
FAS	Financial Accounting Standard
FC	Fingerprint Card
FCA	Functional Configuration Audit
FCE	Flight Crew Equipment
FCT	Flight Control Teams
FDIR	Fault Detection, Isolation and Recovery
FDO	Fee Determination Official
FF	Finish to Finish
FFBD	Functional Flow Block Diagrams
FIPS	Federal Information Processing Standard
FMEA	Failure Modes Effects Analyses
FMEA/CIL	Failure Modes Effects Analyses and Critical Items List
F.O.B.	Free On Board
FOD	Foreign Object Debris
FOIA	Freedom of Information Act
FOM	Figure of Merit
FOUO	For Official Use Only
FPR	Final Proposal Revision
FQT	Formal Qualification Test
FRR	Flight Readiness Review
FS	Finish to Start
FTA	Fault Tree Analysis
FTA	Free Trade Agreement
FTA	Flight Test Article
FTE	Full Time Equivalent
FTS	Flight Termination System
FY	Fiscal Year
G&A	General & Administrative
GAO	General Accounting Office
GBL	Government Bill of Lading
GFE	Government Furnished Equipment
GFI	Government Furnished Information
GFP	Government Furnished Property
GFY	Government Fiscal Year
GIDEP	Government Industry Data Exchange Program
GL	Glenn Research Center
GLOW	Gross Lift Off Weight
GN&C	Guidance, Navigation & Control
GNUG	Ground Network Users' Guide
GO	Goddard Space Flight Center

## Crew Exploration Vehicle – (CEV)

GOTS	Government-Off-The-Shelf
GPS	Global Positioning System
GSA	General Services Administration
GSE	Ground Support Equipment
GTA	Government Task Agreement
HBCU	Historically Black Colleges and Universities
HDBK	Handbook
HQ	Headquarters
HR	Human Resources
HRA	Human Reliability Analysis
HSIS	Human Systems Integration Standards
HUBZone	Historically Underutilized Business Zone
HWCI	Hardware Configuration Items
HWIL	Hardware-in-the-Loop
IA	Information Assurance
IBR	Integrated Baseline Review
ICD	Interface Control Document
ICE	Integrated Collaborative Environment
ID	Identification
IDEFO	Integrated Definition for Function Modeling
IDIQ	Indefinite Delivery, Indefinite Quantity
IE&RS	Industrial, Environmental, and Range Safety
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IG	Inspector General
ILS	Integrated Logistics Support
ILSP	Integrated Logistics Support Plan
IM&S	Integrated Modeling & Simulation
IMP	Integrated Master Plan
IMS	Integrated Master Schedule
IMU	Inertial Measurement Unit
INA	Iranian Nonproliferation Act
IOC	In-Orbit Checkout
IP	Internet Protocol
IPPD	Integrated Product & Process Development
IPT	Integrated Product Team
IRD	Interface Requirements Document
IRS	Internal Revenue Service
IRS	Interface Requirements Specification
IRT	Indirect Rate Template
ISO	International Organization for Standardization
ISP	Information Sharing Protocol
ISS	International Space Station
IT	Information Technology



## Crew Exploration Vehicle – (CEV)

ITAR	International Traffic in Arms Regulation
ITD	Inception To Date
ITO	Information Technology Office
ITS	Information Technology System
IV&V	Independent Verification & Validation
IVHM	Integrated Vehicle Health Management
JBOSC	Joint Base Operations Support Contractor
JO	Johnson Space Center
JSC	Johnson Space Center
KE	Kennedy Space Center
KPP	Key Performance Parameters
KSC	Kennedy Space Center
LA	Langley
LAS	Launch Abort System
LCC	Life Cycle Cost
LCCE	Life Cycle Cost Estimate
LEO	Low Earth Orbit
LET	Linear Energy Transfer
LF	Late Finish
LIDS	Low Impact Docking System
LMS	Logistics Management System
LOC	Loss of Crew
LOE	Level of Effort
LPP	Lightning Protection Plan
LRR	Launch Readiness Review
LRRF	Lunar Risk Reduction Flight
LRU	Line Replaceable Unit
LS	Late Start
LSA	Logistics Support Analysis
LSAM	Lunar Surface Access Module
LSAR	Logistics Support Analysis Records
LV	Launch Vehicle
M&P	Materials & Processes
M&S	Modeling & Simulation
MCPR	Modified Cost Performance Report
MAPTIS	Materials and Processes Technical Information System
MCT	Material Cost Template
MDP	Maximum Design Pressure
MEOP	Maximum Expected Operating Pressure
MI	Minority Institutions
MIL	Military
MIL-STD	Military Standard
MIUL	Materials Identification and Usage List
MLD	Master Logic Diagrams

## Crew Exploration Vehicle – (CEV)

MMOD	Micrometeoroid and Orbital Debris
MMP	Margins Management Plan
MOI	Moment Of Inertia
MR	Management Reserve
MRB	Material Review Board
MS	Microsoft
MSFC	Marshall Space Flight Center
MSIS	Man Systems Integration Standards
MTBF	Mean Time between Failure
MTBME	Mean Time between Maintenance Events
MTTF	Mean Time to Failure
MUA	Materials Usage Agreements
MVP	Master Verification Plan
NAC	National Agency Check
NAICS	North American Industry Classification System
NASA	National Aeronautics and Space Administration
NDE	Non Destructive Evaluation
NDT	Nondestructive Test
NEPA	National Environmental Policy Act
NExIOM	NASA Exploration Information Ontology Model
NFNMS	NASA Foreign National Management System
NFPA	National Fire Protection Act
NFS	NASA FAR Supplement
NITR	NASA Information Technology Requirement
NLR	Non Labor Resources
NODIS	NASA Online Directives Information System
NOI	Notice of Interest
NPD	NASA Policy Directive
NPR	NASA Policy Requirements
NSN	National Stock Number
NSPD	National Security Presidential Directive
NSTS	National Space Transportation System
NTIA	National Telecommunications and Information Administration
NWODB	New Ways Of Doing Business
O&M	Operations and Maintenance
ODCIDP	Onboard Displays and Crew Interface Design Plan
ODCT	Other Direct Costs Template
OMB	Office of Management and Budget
OML	Outer Mold Line
OMDP	Operations and Maintenance Documentation
OP	Operating Plan
ORU	Orbital Replacement Unit
OSH	Occupational Safety and Health
OSHA	Occupational Safety & Health Act

PAS	Pre-award Survey
PC	Pressurized Cargo
PC	Personal Computer
PCA	Physical Configuration Audit
PDA	Probabilistic Design Analysis
PDF	Portable Document Format
PDR	Preliminary Design Review
PEB	Performance Evaluation Board
PEB-IT	Performance Evaluation Board Integration Team
PEBR	PEB-IT Report
PHA	Preliminary Hazards Analysis
PHS&T	Packaging, Handling, Storage and Transportation
PM	Program Manager
PMB	Performance Measurement Baseline
PMP	Project Management Plan
PMR	Performance Management Review
POP	Program Operating Plan
PPA	Pollution Prevention Act
PPE	Personnel Protective Equipment
PRA	Probabilistic Risk Assessment
PRAG	Performance Risk Assessment Group
PRACA	Problem Reporting And Corrective Action
PRD	Program Requirements Document
PROTAP	Project Tasks Planning
PTC	Passive Thermal Control
PTCDDB	Passive Thermal Control Design and Data Book
PV	Procedure Validation
QA	Quality Assurance
QTP	Qualification Test Procedure
R	Resources
R&M	Reliability & Maintainability
RBDA	Reliability Block Diagram Analysis
RC	Reporting Category
RCM	Reliability Centered Maintenance
RCS	Reaction Control System
RDCG	Risk-Driven Cost Growth
RDSG	Risk-Driven Schedule Growth
RF	Radio Frequency
RFP	Request For Proposal
RFV	Request for Visit
RID	Review Item Discrepancy
RMS	Reliability, Maintainability, and Supportability
RQ	Requirements
RRF	Risk Reduction Flight

## Crew Exploration Vehicle – (CEV)

RSPL	Recommended Spares Parts List
RSS	Range Safety System
S&MA	Safety & Mission Assurance
SA	Software Assurance
SA	Spacecraft Adapter
SAA	Space Act Agreements
SAE	Society of Automotive Engineers
SAR	System Acceptance Review
SB	Small Business
SBA	Simulation Based Acquisition
SC	Subcontractor
SCCT	Subcontractor Cost Template
SCM	Software Configuration Management
SCT	Supply Cost Template
SDB	Small Disadvantaged Business
SDD	Software Design Description
SDR	System Definition Review
SE	System Engineering
SE&I	System Engineering & Integration
SEMO	Supply and Equipment Management Officer
SEMP	Systems Engineering Management Plan
SEU	Single Event Upset
SF	Standard Form
SFAC	Space Flight Advisory Committee
SHA	System Hazard Analysis
SI	Systems Integration
SIC	Standard Industrial Code
SIL	Software-in-the-Loop
SLOC	Source Lines Of Code
SM	Service Module
SNUG	Space Network Users' Guide
SOO	Statement Of Objectives
SOW	Statement Of Work
SPEC	Specification
SPI	Schedule Performance Index
SQA	Software Quality Assurance
SRD	System Requirements Document
SRR	Systems Requirements Review
SRS	Software Requirements Specification
SRU	Shop Replaceable Unit
SS CDR	Subsystem Critical Design Review
SS PDR	Subsystem Preliminary Design Review
SSA	Source Selection Authority
SSAC	Source Selection Advisory Committee

SSET	Source Selection Evaluation Team
SSHA	Subsystem Hazard Analysis
SSP	Space Shuttle Program
ST	Stennis
STD	Standard
SVMF	Space Vehicle Mockup Facility
SW	Software
SwRR	Software Requirements Review
TA	Technical Approach
T&V	Test & Verification
TBD	To Be Determined
TBR	To Be Resolved
TBS	To Be Supplied
TCT	Travel Cost Template
TDDB	Thermal Design and Data Book
TDRSS	Tracking and Data Relay Satellite System
TIN	Taxpayer Identification Number
TPM	Technical Performance Measures
TPP	Technical Performance Parameters
TPS	Thermal Protection System
TPSDDDB	Thermal Protection System Design and Data Book
TRL	Technology Readiness Level
TRR	Test Readiness Review
TT&E	Test, Teardown, & Evaluation
U.S.C.	United States Code
UB	Undistributed Budget
UML	Unified Modeling Language
UN/EDIFACT	United Nations Electronic Data Interchange for Administration, Commerce and Transport
US	United States
USAF	United States Air Force
USPS	United States Postal Service
V&V	Verification & Validation
VAFB	Vandenberg Air Force Base
VV&A	Verification, Validation & Accreditation
WBS	Work Breakdown Structure
WYE	Work Year Equivalent

## **ATTACHMENT J-14**

### **INTEGRATED COLLABORATIVE ENVIRONMENT (ICE) OPERATING ENVIRONMENT**

## Crew Exploration Vehicle - (CEV)

**Section I – Background/Overview:** The Integrated Collaborative Environment (ICE) is a major tool for NASA's Exploration Systems Mission Directorate (ESMD) programmatic management activities and allows identification, collection, analyses, and dissemination of data and information associated with the Agency's goals and mission. ICE provides a secure data repository with the necessary access control for data protection in conjunction with a collaborative environment. This enables real time decision-making relative to program and project deliverables. ICE is an integral component for decision support throughout the program and projects' life cycles and is based on the availability of needed information to team members involved in decision making. The ESMD programs and projects will use ICE to facilitate effective feedback, efficient change management and rapid change propagation. ICE will also support a wide variety of other uses. Some of these include: support for management reviews, support for minor and major design reviews, linking users of the tools, support to team meetings, issue recording, etc.

NASA is responsible for implementing ICE and has done so using a suite of commercial-off-the-shelf licensed software tools as the core elements of the solution. NASA's ICE operates as an extranet environment that is physically separate from any other non-ESMD network and is dedicated to the ESMD programs and projects. The ESMD Chief Information Officer (CIO) organization manages authorization and authentication. Access control policies are developed and maintained by the ESMD CIO organization and can be applied at the individual object level. All NASA sites and Contractors are expected to request and implement ICE licenses and to use the system as a collaboration tool with the ESMD program and projects and as a source of all relevant data. The ESMD program and projects will provide access and Contractor training personnel to a limited set of users from the Contractor. The Contractor must assess their participation to determine the number of personnel who will need access. As guidance, any individual that contributes to the process of defining, collaborating, reviewing, and delivering contributions to the CEV Project will need an ICE license. This includes both inter-company and intra-company collaborative activities. Additionally, other users may include many of the following persons involved in collaboration with other project element organizations, such as:

1. Procurement & Supplier Management Personnel
2. Engineers
3. IT Personnel
4. Manufacturing & Assembly Personnel
5. Administration
6. Simulation, Testing & Analysis Engineers

ICE will provide virtual meeting and real time information sharing activities via an on line meeting tool.

The ICE Program Office is currently building a capability to create a fully distributed information environment which will enable the ESMD programs and projects to reach data objects at Contractor and NASA sites and interrogate them. Upon identifying information required to support actions, access to the data will be available to all who have the correct access controls. Data with restricted rights markings will be access controlled and disseminated in accordance with the contractually established agreements. ICE will use several levels of access controls to ensure security of sensitive data.

## Crew Exploration Vehicle - (CEV)

**Section II – ESMD ICE Data Requirements:** The Contractor shall comply with the following requirements for making their data a part of the Integrated Collaborative Environment:

**Data Access Requirements:** The Contractor shall deliver the data to ESMD using one of the following two options:

- 1) Use the ESMD ICE directly to develop and manage Contractor data. The Contractor personnel will be provided licenses and access to the ICE environment and will do their day-to-day work in the ICE environment. (This option is intended for companies which do not have an existing set of tools and infrastructure.)
- 2) Provide access to the Contractor's data through the internet using JMS and SOAP protocol. Authentication will be X.509 based and information will reside within the Contractor's native systems. ICE access will be accomplished through the use of a credentialing mechanism mutually agreed upon by the Contractor and NASA. As stated previously, several levels of access controls will be used for security of sensitive data. As part of this architecture, ICE will communicate with the Contractor's Information Technology (IT) systems via an integration broker (i.e. middleware technology)-to-integration broker communication using JMS/SOAP. The following is meant to be a representative, but not complete, list of the interactions which can occur between NASA's ICE and the Contractor's IT environment:
  - a. Services that update ICE with new/updated files, objects, and application activity.
  - b. Services that participate in, publish, and subscribe broker service.
  - c. Services that have a set of events that the integration broker responds to.

The Contractor shall work with NASA to develop a directory structure that addresses the needs of NASA program and project integration. This directory structure shall be documented in the Contractor Configuration Management Plan. To ensure its integration across all of ESMD, the Configuration Management Plan shall be reviewed and approved by the Constellation Program Office and the ESMD CIO, as well as by the CEV Project Office.

**Data Exchange Requirements:**

- 1) Send and receive JMS/SOAP messages to ICE to keep aware of local activity
  - a. JMS/SOAP messages would include, but are not limited to:
    - i. ID of object (e.g. file name)
    - ii. Name of object (e.g. Avionics Package)
    - iii. Version of object (e.g. Rev A)
    - iv. State of object as defined by ICE Program Office (e.g. In Work, Released, etc)
    - v. Type of object (e.g. CAD File)
    - vi. Security profile of object (e.g. Classified, Unclassified)
    - vii. Association categories for object product structure
      1. Used on (e.g. Part, Model, WBS)
      2. Uses (e.g. Part, Model, WBS)
      3. Described by
      4. Describes
      5. Analyzed by
      6. Analyzes ...
- 2) Translate native CAD geometry (e.g. Unigraphics) into ProductView format for visualization purposes.
- 3) All objects must have an association to the CEV WBS.
- 4) Objects must have an association to a part (if appropriate).
- 5) To provide separate instances of classified (if necessary) and unclassified information.
- 6) Update ICE meta data and content when changed and in accordance with the associated business process.



## Crew Exploration Vehicle - (CEV)

- 7) Required objects that must be synchronized within ICE include, but are not limited to:
  - a. Parts
  - b. Bills of materials
  - c. Software
  - d. Manufacturing plans
  - e. Generic documents
  - f. 3-D Models
  - g. Test data (Estimated, Calculated)
  - h. Analysis Data (Engineering, Hardware/Software integration, Interoperability)
  - i. Trade studies
  - j. Specifications
  - k. Technical assessments
  - l. Test plans
  - m. Test results for modeling and simulation
- 8) Documentation of modeling and simulation run
  - a. Description
  - b. Software
  - c. Models
  - d. Constraints
  - e. H/W, S/W, Operating System (O/S)
- 9) Measures of Performance, Measures of Effectiveness.
- 10) Unified Modeling Language (UML) diagrams.
- 11) Component reliability/maintainability data.
- 12) Interface specifications and procedures.
- 13) Properties data for interfaces
  - a. Mechanical
  - b. Physical
  - c. Electrical
  - d. Functional
- 14) Technical Performance Measures.
- 15) Follow the ESMD CIO organization naming conventions.
- 16) Only the ESMD CIO organization can authorize the removal of ESMD data once it is released.
- 17) Formats used on ICE include, but are not limited to;
  - a. Microsoft Office® (Word, Excel, PowerPoint, Visio, Project)
  - b. Rational Rose UML Models
  - c. ASCII Text Data
  - d. Adobe Acrobat PDF
  - e. JPEG
  - f. MPEG
  - g. AVI
  - h. HTML
  - i. RTF
  - j. XML
  - k. GIF

Note: The ESMD CIO organization will specify the version of these applications separately and Contractors will be given six months to move to those versions.

The ESMD CIO organization will participate with the NASA sites and/or Contractors to coordinate and establish the integration with the Integrated Collaborative Environment.

**ICE Tools:** The ICE Architecture does not require the Contractor to use any particular set of tools; however, there are always questions as to what tools make up ICE. The following is provided to the Contractor for informational purposes:

Systems Engineering – Cradle  
Product Life Cycle Management – Windchill

**Crew Exploration Vehicle - (CEV)**

1. CAD Data Management
2. Configuration Management
3. Data Management
4. Product Structure
5. Document Management
6. Project Collaboration

Risk Management – Active Risk Manager (ARM)

Earned Value Management – Primavera and wlnsight

Integrated Master Schedule/Integrated Master Plan – Primavera

MCAD – Pro/Engineer®

**Licenses for Applications:** With minor exceptions, the Contractor is responsible for acquiring their own licenses for the applications listed in item 17 noted above.

## **ATTACHMENT J-15**

### **INTEGRATED MASTER PLAN**

**LOCKHEED MARTIN PROPRIETARY INFORMATION**

Use or disclosure of data contained on this sheet is subject to the restriction on the title page of this proposal.

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Attachment J-16

Crew Exploration Vehicle (CEV)

**ATTACHMENT J-16**

**INTEGRATED PROJECT SCHEDULE**

**ATTACHMENT J-17**

**AWARD FEE EVALUATION PLAN  
CREW EXPLORATION VEHICLE  
Schedule C**

## **I. INTRODUCTION**

In accordance with the provisions of the Federal Acquisition Regulation (FAR), and NASA and JSC policies, a performance evaluation procedure is hereby established for determination of award fees payable under this contract. The award fee is designed to provide economic motivation for the Contractor to provide timely, high quality outputs that exceed the minimum requirements of the contract. The intent of this plan is to set up procedures for evaluation of Contractor performance using existing data and systems to the maximum extent while imposing minimum administrative burden on the Government and contractor. The payment of any award fee is contingent upon compliance with contractual requirements and performance to the degree specified below.

This contract is a hybrid contract consisting of three schedules, Schedules A, B, and C. Schedules A and C award fee evaluation plans are covered by attachments J-7 and J-17, respectively. Schedule B contains separate incentives specific to that contract schedule, and is not subject to award fee provisions.

The Contractor's performance for Schedule C will be evaluated by NASA at the expiration of each period specified in Enclosure II, Award Fee Distribution. The evaluation to be performed by NASA will be based on NASA's assessment of the Contractor's accomplishment of the various areas of work covered by the Statement of Work and the tasks issued, in accordance with the factors, weightings, procedures, and other provisions set forth below and in specific task orders.

The amount of available Award Fee in each period is subject to equitable adjustments arising from changes or other contract modifications. The amount of the Award Fee to be paid is determined by the Government's judgmental evaluation of the Contractor's performance in terms of the criteria stated in the contract. This determination and the methodology for determining the Award Fee are unilateral decisions made solely at the discretion of the Government. The Government may unilaterally change any areas of this plan not otherwise requiring mutual agreement under the contract. Such changes will be made prior to the beginning of an evaluation period to which the changes apply by timely notice to the Contractor in writing. The Contractor will be informed of any changes to the evaluation criteria or the weightings prior to the affected Award Fee period.

Each fee evaluation rating is discrete and final. Unearned fee in a given period cannot be reassessed or moved into subsequent fee evaluation periods for consideration.

## **II. ORGANIZATIONAL STRUCTURE**

### **A. Performance Evaluation Board Integration Team (PEB-IT)**

The PEB-IT will be composed of selected NASA technical and administrative personnel and headed by the Contracting Officer's Technical Representative (COTR). The COTR will be the focal point for the accumulation and development of Award Fee evaluation reports, reviews, and presentations, as well as discussions with Contractor management on Award Fee matters. The PEB-IT will evaluate the Contractor's performance as related to the criteria listed in paragraph III below.

The PEB-IT will furnish the Contractor performance evaluations at the midpoint of the award fee period. The purpose of these communications is to discuss any specific areas where the contractor has excelled and areas where future improvement is necessary.

The PEB-IT will prepare an evaluation report for review by the PEB for each evaluation period. This report will include a recommendation to the PEB as to the adjective rating and numerical score, as defined in enclosure I, to be assigned for the Contractor's performance for the period evaluated.

### **B. Performance Evaluation Board (PEB)**

The Performance Evaluation Board (PEB) will be comprised of selected technical and administrative personnel of NASA. The PEB will assess the Contractor's performance after each evaluation period to determine whether, and to what extent, the Contractor's performance during the evaluation period is deserving of the payment of Award Fee. The PEB, at the end of each evaluation period, will approve the PEB-IT report (PEBR) and prepare a summary of the evaluations for review by the Fee Determination Official (FDO). This summary will include a recommendation to the FDO as to the adjective rating and numerical score to be assigned for the Contractor's performance in the preceding evaluation period.

### **C. Fee Determination Official**

The Senior NASA Official will be the FDO. After considering available pertinent information and recommendations, the FDO will make a performance determination for each period in accordance with the provisions of this Attachment J-17 and the terms and conditions applicable to Schedule C. The FDO will consider the recommendation of the PEB, PEB-IT Report, information provided by the Contractor, if any, and any other pertinent information in determining the performance score. The FDO's determination of the score will be stated in a written Award Fee Determination and will be provided to the Contractor by the Contracting Officer within 45 calendar days after the end of the evaluation period.

### **III. EVALUATION PROCEDURES**

#### **Award Fee Periods**

Each award fee period shall be 6 months in length.

#### **Objective and Subjective Criteria**

No later than 30 calendar days prior to the start of each Award Fee period, the Contractor may submit to the Contracting Officer recommended objective performance metrics, weightings, and Areas of Emphasis (AOE) for consideration by NASA to be used for the ensuing evaluation period.

NASA may establish performance metrics and AOE for each evaluation period and communicate these to the Contractor at least 15 calendar days prior to the start of each evaluation period. NASA may unilaterally change the weightings of the criteria from period to period. However, cost control will not fall below 25 percent.

#### **Contractor Self Evaluation and Submissions**

The Contractor shall furnish a self-evaluation for each evaluation period. The self-evaluation must be received by the Contracting Officer 5-working days prior to the end of the period and shall be limited to no more than 10 pages.

The Contractor will be furnished a copy of the PEB findings, conclusions, and fee recommendation. The Contractor will be afforded the opportunity to submit for consideration of the FDO: (a) proposed evaluations or conclusions or (b) exceptions to the evaluations, conclusions, or fee recommendations of the PEB; and (c) supporting reasons for such exceptions or proposed evaluations or conclusions. The Contractor's submissions must be made in writing and must be submitted through the Contracting Officer to the FDO within 5-working days from the date of the Contractor's receipt of the PEB findings. If the Contractor does not provide additional information to the Contracting Officer within the time stated above NASA will conclude that the Contractor concurs with the evaluation and recommended score.

In the event the FDO has not received a submission from the Contractor, the performance determination will not be executed until expiration of the 5-working day period prescribed above for contractor submission. The Contractor may waive the 5-working day waiting period by providing a written statement that no response will be submitted.

The Contractor shall submit to the Contracting Officer a Corrective Action Plan (CAP) for any weaknesses or failing objective performance areas identified by NASA as part of the evaluation. The CAP should include a description of the non-conformance, determination of the root cause of the non-conformance, action required to correct the weakness and prevent recurrences, and the schedule for completion of the action. The CAP shall be submitted to the Contracting Officer within 30 calendar days after receipt of each performance determination for the evaluation period. Corrective Actions will be closed by concurrence from the



Contracting Officer and the COTR. Failure to submit a CAP within the timeframe stated above will result in a weakness in the next evaluation period.

#### **IV. EVALUATION CRITERIA AND WEIGHTINGS**

NASA will use the following subjective factors as a basis for arriving at the award fee score for each period:

<u>Award Fee Evaluation Criteria</u>	<u>Total Weight</u>
Technical	45%
Program Management	20%
Cost	25%
Small Business/Small Disadvantaged Business Subcontracting Goals	10%

##### **A. Technical (45%)**

This factor will include an evaluation of the Contractor's performance in all areas of Technical performance. This includes safety and mission assurance, requirements definition and flowdown, risk management, margin management, life cycle cost management and innovation. (Innovation, both here and in Program Management, is defined as innovations that reduce cost, benefit schedule both from a current and future perspective, or result in improved design, coordination, or communication without adverse effects on performance, cost, or schedule.)

##### **B. Program Management (20%)**

This factor will include an evaluation of the Contractor's performance in all areas of Program Management performance. This includes schedule management, subcontract management, responsiveness, life cycle cost management, innovation and corporate commitment to personnel. (Corporate commitment to personnel includes the quantity and quality of personnel assigned to the CEV Phase 2 contract. Quantity includes ramp-up and retention of qualified personnel at adequate levels to meet schedule, cost and performance objectives. Quality of personnel will be evaluated on the Contractor's success in maintaining and replacing key personnel within the CEV Phase 2 contract.)

##### **C. Cost Management (25%)**

This factor will include an evaluation of the Contractor's cost performance under the contract. Earned Value Management System data, cost performance reports and other cost data sources will be used in the Cost Management assessment for this factor. Cost performance will be assessed by evaluating the cost expended on the actual work performed during the period being evaluated, including quantitative assessment of the award fee period cumulative Cost Performance Index (CPI). In addition, a qualitative assessment of appropriate earned value variances, cost implications of the Schedule Performance Index (SPI), and other period-specific cost management trend data will be considered.

**D. Small Business/Small Disadvantaged Business Subcontracting Goals (10%)**

The contractor's performance will be evaluated against the contract goals for small/small disadvantaged business subcontracting.

**V. SCORING**

**The percentage of award fee to be paid for a period is equal to the numerical score assigned.** In accordance with the Section G clause for award fee, no award fee will be paid when Contractor performance is determined to be Poor/Unsatisfactory.

An overall performance evaluation and fee determination of zero shall be made for any evaluation period when there is a major breach of safety or security as defined in NFS 1852.223-75, Major Breach of Safety or Security.

**VI. LIST OF ENCLOSURES**

Enclosure I, Numerical Ranges and Adjective Definitions

Enclosure II, Award Fee Distribution

**Enclosure I**

**Numerical Ranges and Adjective Definitions**

This enclosure sets forth the adjective ratings, definitions, and associated numerical ranges to be used to define the various levels of performance under the contract.

ADJECTIVE RATING	RANGE OF POINTS	Definition
Excellent	100 - 91	Of exceptional merit; exemplary performance in a timely, efficient and economical manner; very minor (if any) deficiencies with no adverse effect on overall performance.
Very Good	90 - 81	Very effective performance, fully responsive to contract; contract requirements accomplished in a timely, efficient and economical manner for the most part; only minor deficiencies.
Good	80 - 71	Effective performance; fully responsive to contract requirements; reportable deficiencies, but with little identifiable effect on overall performance.
Satisfactory	70 - 61	Meets or slightly exceeds minimum acceptable standards; adequate results; reportable deficiencies with identifiable, but not substantial, effects on overall performance.
Poor/Unsatisfactory	60 - 0	Does not meet minimum acceptable standards in one or more areas; remedial action required in one or more areas; deficiencies in one or more areas which adversely affect overall performance.

**Enclosure II**  
**AWARD FEE DISTRIBUTION**

Period No.	Evaluation Periods	Available Fee*	Earned Fee
1	09/08/09 – 03/31/10	\$ TBD	\$TBD
2	04/01/10 – 09/30/10	\$	\$
3	10/01/10 – 03/31/11	\$	\$
4	04/01/11 – 09/3/011	\$	\$
5	10/01/11 – 03/31/12	\$	\$
6	04/01/12 – 09/30/12	\$	\$
7	10/01/12 – 03/31/13	\$	\$
8	04/01/13 – 09/30/13	\$	\$
9	10/01/13 – 03/31/14	\$	\$
10	04/01/14 – 09/07/14	\$	\$
		\$	\$

***\*Estimated for the period. At end of the evaluation period a change will be made to reflect actual available for the period as determined by the Contracting Officer.***

The Indefinite Delivery Indefinite Quantity (IDIQ) Award Fee available for the period as described above will be based on the task order(s) issued and the period of performance of the task orders (currently based on Government Fiscal Year (GFY)). This award fee amount will be used for purposes of provisional award fee payments described in section G of the contract.

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Attachment J-18

Department of Defense Contract Security Classification Specification

DEPARTMENT OF DEFENSE CONTRACT SECURITY CLASSIFICATION SPECIFICATION		1. CLEARANCE AND SAFEGUARDING	
(The requirements of the DoD Industrial Security Manual apply to all aspects of this effort)		a. FACILITY CLEARANCE REQUIRED <input checked="" type="checkbox"/> SECRET	
		b. LEVEL OF SAFEGUARDING REQUIRED <input checked="" type="checkbox"/> SECRET	
2. THIS SPECIFICATION IS FOR: (X and complete as applicable)		3. THIS SPECIFICATION IS: (X and complete as applicable)	
<input checked="" type="checkbox"/> a. PRIME CONTRACT NUMBER NNJ06TA25C		<input checked="" type="checkbox"/> a. ORIGINAL (Complete date in all cases)	Date (YYMMDD)
<input type="checkbox"/> b. SUBCONTRACT NUMBER		<input type="checkbox"/> b. REVISED (Supersedes all previous specs)	Revision No. Date (YYMMDD)
<input checked="" type="checkbox"/> c. SOLICITATION OR OTHER NUMBER NNJ05111915R	Due Date (YYMMDD)	<input type="checkbox"/> c. FINAL (Complete Item 5 in all cases)	Date (YYMMDD)
4. IS THIS A FOLLOW-ON CONTRACT? <input type="checkbox"/> YES <input type="checkbox"/> NO. If Yes complete the following Classified material received or generated under _____ (Preceding Contract Number) is transferred to this follow-on contract			
5. IS THIS A FINAL DD FORM 254? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO. If Yes complete the following In response to the contractor's request dated <u>N/A</u> , retention of the identified classified material is authorized for the period of <u>N/A</u> .			
6. CONTRACTOR (Include Commercial and Government Entity (CAGE) Code)			
a. NAME, ADDRESS, AND ZIP CODE		b. CAGE CODE	
		c. COGNIZANT SECURITY OFFICE (Name, Address, and Zip Code) DSS-Defense Security Service Central Region 5800 East Campus Circle Drive, Suite 110A Irving, TX. 75063-2739	
7. SUBCONTRACTOR			
a. NAME, ADDRESS, AND ZIP CODE		b. CAGE CODE	
		c. COGNIZANT SECURITY OFFICES (Name, Address, and Zip Code)	
8. ACTUAL PERFORMANCE			
a. LOCATION NASA/Johnson Space Center 2101 NASA Parkway Houston, TX 77058-3696		b. CAGE CODE N/A	
		c. COGNIZANT SECURITY OFFICE (Name, Address, and Zip Code) N/A	
9. GENERAL IDENTIFICATION OF THIS PROCUREMENT			
10. THIS CONTRACT WILL REQUIRE ACCESS TO:			
a. COMMUNICATIONS SECURITY (COMSEC) INFORMATION	YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>	
b. RESTRICTED DATA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
c. CRITICAL NUCLEAR WEAPON DESIGN INFORMATION	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
d. FORMERLY RESTRICTED DATA:	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
e. INTELLIGENCE INFORMATION:			
(1) Sensitive Compartmented Information (SCI)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
(2) Non-SCI	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
f. SPECIAL ACCESS INFORMATION	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
g. NATO INFORMATION	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
h. FOREIGN GOVERNMENT INFORMATION	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
i. LIMITED DISSEMINATION INFORMATION	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
j. FOR OFFICIAL USE ONLY INFORMATION	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
k. OTHER Specify)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
11. IN PERFORMING THIS CONTRACT, THE CONTRACTOR WILL:			YES NO
a. HAVE ACCESS TO CLASSIFIED INFORMATION ONLY AT ANOTHER CONTRACTOR'S FACILITY OR A GOVERNMENT ACTIVITY			<input type="checkbox"/> <input checked="" type="checkbox"/>
b. RECEIVE CLASSIFIED DOCUMENTS ONLY			<input type="checkbox"/> <input checked="" type="checkbox"/>
c. RECEIVE AND GENERATE CLASSIFIED MATERIAL			<input type="checkbox"/> <input checked="" type="checkbox"/>
d. FABRICATE, MODIFY, OR STORE CLASSIFIED HARDWARE			<input type="checkbox"/> <input checked="" type="checkbox"/>
e. PERFORM SERVICES ONLY			<input type="checkbox"/> <input checked="" type="checkbox"/>
f. HAVE ACCESS TO U.S. CLASSIFIED INFORMATION OUTSIDE THE U.S., PUERTO RICO, U.S. POSSESSIONS AND TRUST TERRITORIES			<input type="checkbox"/> <input checked="" type="checkbox"/>
g. BE AUTHORIZED TO USE THE SERVICES OF DEFENSE TECHNICAL INFORMATION CENTER (DTIC) OR OTHER SECONDARY DISTRIBUTION CENTER			<input type="checkbox"/> <input checked="" type="checkbox"/>
h. REQUIRE A COMSEC ACCOUNT			<input type="checkbox"/> <input checked="" type="checkbox"/>
i. HAVE A TEMPEST REQUIREMENT			<input type="checkbox"/> <input checked="" type="checkbox"/>
j. HAVE OPERATIONS SECURITY (OPSEC) REQUIREMENTS			<input type="checkbox"/> <input checked="" type="checkbox"/>
k. BE AUTHORIZED TO USE THE DEFENSE COURIER SERVICE			<input type="checkbox"/> <input checked="" type="checkbox"/>
l. OTHER (Specify). SEE BLOCK 13 REMARKS			<input checked="" type="checkbox"/> <input type="checkbox"/>

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Attachment J-18

Department of Defense Contract Security Classification Specification

DEPARTMENT OF DEFENSE CONTRACT SECURITY CLASSIFICATION SPECIFICATION			1. CLEARANCE AND SAFEGUARDING	
(The requirements of the DoD Industrial Security Manual apply to all aspects of this effort)			a. FACILITY CLEARANCE REQUIRED <input checked="" type="checkbox"/> SECRET	
			b. LEVEL OF SAFEGUARDING REQUIRED <input checked="" type="checkbox"/> SECRET	
2. THIS SPECIFICATION IS FOR: (X and complete as applicable)			3. THIS SPECIFICATION IS: (X and complete as applicable)	
<input checked="" type="checkbox"/>	a. PRIME CONTRACT NUMBER <b>NNJ06TA25C</b>		<input checked="" type="checkbox"/>	a. ORIGINAL (Complete date in all cases) Date (YYMMDD)
<input type="checkbox"/>	b. SUBCONTRACT NUMBER		<input type="checkbox"/>	b. REVISED (Supersedes all previous specs) Revision No. _____ Date (YYMMDD)
<input checked="" type="checkbox"/>	c. SOLICITATION OR OTHER NUMBER <b>NNJ05111915R</b>	Due Date (YYMMDD)	<input type="checkbox"/>	c. FINAL (Complete Item 5 in all cases) Date (YYMMDD)
4. IS THIS A FOLLOW-ON CONTRACT? <input type="checkbox"/> YES <input type="checkbox"/> NO. If Yes complete the following Classified material received or generated under _____ (Preceding Contract Number) is transferred to this follow-on contract				
5. IS THIS A FINAL DD FORM 254? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO. If Yes complete the following In response to the contractor's request dated <u>N/A</u> , retention of the identified classified material is authorized for the period of <u>N/A</u> .				
6. CONTRACTOR (Include Commercial and Government Entity (CAGE) Code)				
a. NAME, ADDRESS, AND ZIP CODE		b. CAGE CODE	c. COGNIZANT SECURITY OFFICE (Name, Address, and Zip Code) <b>DSS-Defense Security Service Central Region 5800 East Campus Circle Drive, Suite 110A Irving, TX. 75063-2739</b>	
7. SUBCONTRACTOR				
a. NAME, ADDRESS, AND ZIP CODE		b. CAGE CODE	c. COGNIZANT SECURITY OFFICES (Name, Address, and Zip Code)	
8. ACTUAL PERFORMANCE				
a. LOCATION <b>NASA/Johnson Space Center 2101 NASA Parkway Houston, TX 77058-3696</b>		b. CAGE CODE <b>N/A</b>	c. COGNIZANT SECURITY OFFICE (Name, Address, and Zip Code) <b>N/A</b>	
9. GENERAL IDENTIFICATION OF THIS PROCUREMENT				
10. THIS CONTRACT WILL REQUIRE ACCESS TO:				
a. COMMUNICATIONS SECURITY (COMSEC) INFORMATION	YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>	11. IN PERFORMING THIS CONTRACT, THE CONTRACTOR WILL:	
b. RESTRICTED DATA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	a. HAVE ACCESS TO CLASSIFIED INFORMATION ONLY AT ANOTHER CONTRACTOR'S FACILITY OR A GOVERNMENT ACTIVITY	YES <input type="checkbox"/> NO <input checked="" type="checkbox"/>
c. CRITICAL NUCLEAR WEAPON DESIGN INFORMATION	<input type="checkbox"/>	<input checked="" type="checkbox"/>	b. RECEIVE CLASSIFIED DOCUMENTS ONLY	<input type="checkbox"/> <input checked="" type="checkbox"/>
d. FORMERLY RESTRICTED DATA:	<input type="checkbox"/>	<input checked="" type="checkbox"/>	c. RECEIVE AND GENERATE CLASSIFIED MATERIAL	<input type="checkbox"/> <input checked="" type="checkbox"/>
e. INTELLIGENCE INFORMATION:			d. FABRICATE, MODIFY, OR STORE CLASSIFIED HARDWARE	<input type="checkbox"/> <input checked="" type="checkbox"/>
(1) Sensitive Compartmented Information (SCI)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	e. PERFORM SERVICES ONLY	<input type="checkbox"/> <input checked="" type="checkbox"/>
(2) Non-SCI	<input type="checkbox"/>	<input checked="" type="checkbox"/>	f. HAVE ACCESS TO U.S. CLASSIFIED INFORMATION OUTSIDE THE U.S., PUERTO RICO, U.S. POSSESSIONS AND TRUST TERRITORIES	<input type="checkbox"/> <input checked="" type="checkbox"/>
f. SPECIAL ACCESS INFORMATION	<input type="checkbox"/>	<input checked="" type="checkbox"/>	g. BE AUTHORIZED TO USE THE SERVICES OF DEFENSE TECHNICAL INFORMATION CENTER (DTIC) OR OTHER SECONDARY DISTRIBUTION CENTER	<input type="checkbox"/> <input checked="" type="checkbox"/>
g. NATO INFORMATION	<input type="checkbox"/>	<input checked="" type="checkbox"/>	h. REQUIRE A COMSEC ACCOUNT	<input type="checkbox"/> <input checked="" type="checkbox"/>
h. FOREIGN GOVERNMENT INFORMATION	<input type="checkbox"/>	<input checked="" type="checkbox"/>	i. HAVE A TEMPEST REQUIREMENT	<input type="checkbox"/> <input checked="" type="checkbox"/>
i. LIMITED DISSEMINATION INFORMATION	<input type="checkbox"/>	<input checked="" type="checkbox"/>	j. HAVE OPERATIONS SECURITY (OPSEC) REQUIREMENTS	<input type="checkbox"/> <input checked="" type="checkbox"/>
j. FOR OFFICIAL USE ONLY INFORMATION	<input checked="" type="checkbox"/>	<input type="checkbox"/>	k. BE AUTHORIZED TO USE THE DEFENSE COURIER SERVICE	<input type="checkbox"/> <input checked="" type="checkbox"/>
k. OTHER (Specify)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	l. OTHER (Specify). <b>SEE BLOCK 13 REMARKS</b>	<input checked="" type="checkbox"/> <input type="checkbox"/>

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## **ATTACHMENT J-19**

### **PRIVACY IDENTITY VERIFICATION (PIV) CARD ISSUANCE PROCEDURES**

**PIV Card Issuance Procedures in accordance with** FAR clause 52.204-9, Personal Identity Verification of Contractor Personnel

FIPS 201 Appendix A graphically displays the following procedure for the issuance of a PIV credential.

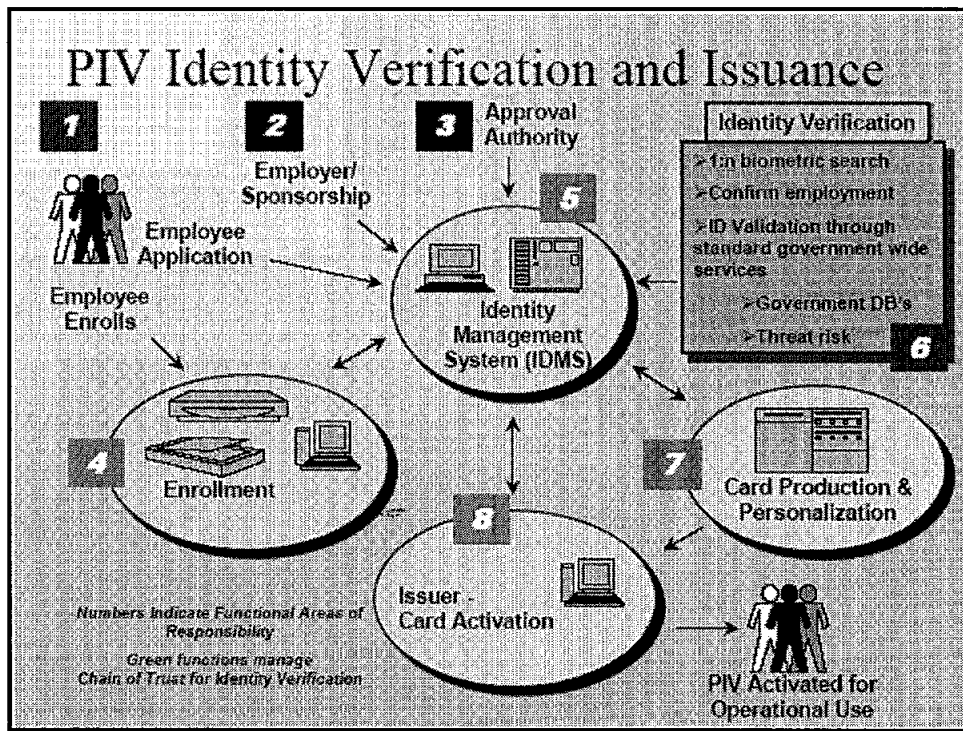


Figure A-1, FIPS 201, Appendix A

The following steps describe the procedures for the NASA Personal Identity Verification Card Issuance (PCI) of a PIV credential:

**Step 1:**

The Contractor's Corporate Security Officer (CSO), Program Manager (PM), or Facility Security Officer (FSO) submits a formal letter that provides a list of contract employees (applicant) names requesting access to the NASA Contracting Officer's Technical Representative (COTR). In the case of a foreign national applicant, approval through the NASA Foreign National Management System (NFMMS) must be obtained for the visit or assignment before any processing for a PIV credential can take place. Further, if the foreign national is not under a contract where a COTR has been officially designated, the foreign national will provide the information directly to their visit/assignment host, and the host sponsor will fulfill the duties of the COTR mentioned herein. In each case, the letter shall provide notification of the contract or foreign national employee's (hereafter the "applicant") full name (first, middle and last), social security number (SSN) or NASA Foreign National Management System Visitor Number if the foreign national does not have a SSN, and date of birth. If the contract employee has a current satisfactorily completed National Agency Check with Inquiries (NACI) or an equivalent or higher degree of background investigation, the letter shall indicate the type of investigation, the agency completing the investigation, and date the investigation was completed. Also, the letter must specify the risk/sensitivity level associated with the position in which each applicant will be working (NPR 1600.1, §4.5 is



Germane) Further, the letter shall also acknowledge that contract employees may be denied access to NASA information or information systems based on an unsatisfactory background investigation/adjudication. .

After reviewing the letter for completeness and concurring with the risk/sensitivity levels, the COTR/host must forward the letter to the Center Chief of Security (CCS). The CCS shall review the OPM databases (e.g., DCII, PIP, et al.), and take appropriate steps to validate the applicant's investigation status. Requirements for a NACI or other investigation shall be initiated only if necessary.

Applicants who do not currently possess the required level of background investigation shall be directed to the e-QIP web site to complete the necessary background investigation forms online. The CCS shall provide to the COTR/host information and instructions on how to access the e-QIP for each contract or foreign national employee requiring access

**Step 2:**

Upon acceptance of the letter/background information, the applicant will be advised that in order to complete the investigative process, he or she must appear in-person before the authorized PIV registrar and submit two forms of identity source documents in original form. The identity source documents must come from the list of acceptable documents included in Form I-9, Employment Eligibility Verification, one which must be a Federal<sup>1</sup> or State issued picture identification. Fingerprints will be taken at this time. The applicant must appear **no later than** the entry on duty date.

When the applicant appears, the registrar will electronically scan the submitted documents; any document that appears invalid will be rejected by the registrar. The registrar will capture electronically both a facial image and fingerprints of the applicant. The information submitted by the applicant will be used to create or update the applicant identity record in the Identity Management System (IDMS).

**Step 3:**

Upon the applicant's completion of the investigative document, the CCS reviews the information, and resolves discrepancies with the applicant as necessary. When the applicant has appeared in person and completed fingerprints, the package is electronically submitted to initiate the NACI. The CCS includes a request for feedback on the NAC portion of the NACI at the time the request is submitted.

**Step 4:**

Prior to authorizing physical access of a contractor employee to a federally-controlled facility or access to a Federal information system, the CCS will a National Crime Information Center (NCIC) with an Interstate Identification Index check is/has been performed. In the case of a foreign national, a national check of the Bureau of Immigration and Customs Enforcement (BICE) database will be performed for each applicant. If this process yields negative information, the CCS will immediately notify the COTR/host of the determination regarding access made by the CCS.

**Step 5:**

Upon receipt of the completed NAC, the CCS will update IDMS from the NAC portion of the NACI and indicate the result of the suitability determination. If an unsatisfactory suitability determination is rendered, the

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<sup>1</sup> A non-PIV government identification badge, including the NASA Photo Identification Badge, MAY NOT BE USED for the original issuance of a PIV vetted credential

COTR will advise the contractor that the employee is being denied physical access to all federally-controlled facilities and Federal information systems.

Based on a favorable NAC and NCIC/III or BICE check, the CCS will authorize the issuance of a PIV federal credential in the Physical Access Control System (PACS) database. The CCS, based on information provided by the COTR/host, will determine what physical access the applicant should be granted once the PIV issues the credential.

**Step 6:**

Using the information provided by the applicant during his or her in-person appearance, the PIV card production facility creates and instantiates the approved PIV card for the applicant with an activation date commensurate with the applicant's start date.

**Step 7:**

The applicant proceeds to the credential issuance facility to begin processing for receipt of his/her federal credential.

The applicant provides to the credential issuing operator proof of identity with documentation that meets the requirements of FIPS 201 (DHS Employment Eligibility Verification (Form I-9) documents. These documents **must** be the same documents submitted for registration.

The credential issuing operator will verify that the facial image, and optionally reference finger print, matches the enrollment data used to produce the card. Upon verification of identity, the operator will locate the employee's record in the PACS database, and modify the record to indicate the PIV card has been issued. The applicant will select a PIN for use with his or her new PIV card. Although root data is inaccessible to the operator, certain fields (hair color, eye color, et al.) may be modified to more accurately record the employee's information.

The applicant proceeds to a kiosk or other workstation to complete activation of the PIV card using the initial PIN entered at card issuance.

**ALTERNATIVE FOR APPLICANTS WHO DO NOT HAVE A COMPLETED AND ADJUDICATED  
NAC AT THE TIME OF ENTRANCE ON DUTY**

Steps 1 through 4 shall be accomplished for all applicants in accordance with the process described above. If the applicant is unable to appear in person until the time of entry on duty, or does not, for any other reason, have a completed and adjudicated NAC portion of the NACI at the time of entrance on duty, the following interim procedures shall apply.

1. If the documents required to submit the NACI have not been completed prior to EOD, the applicant will be instructed to complete all remaining requirements for submission of the investigation request. This includes presentation of I-9 documents and completion of fingerprints, if not already accomplished. If the applicant fails to complete these activities as prescribed in NPR 1600.1 (Chapters 3 & 4), it may be considered as failure to meet the conditions required for physical access to a federally-controlled facility or access to a Federal information system, and result in denial of such access.
2. Based on favorable results of the NCIC, the applicant shall be issued a temporary NASA identification card for a period not-to-exceed six months. If at the end of the six month period the NAC results have not been returned, the agency will at that time make a determination if an additional extension will be granted for the temporary identification card.
3. Upon return of the completed NAC, the process will continue from Step 5.

# ATTACHMENT J-20

CREW EXPLORATION VEHICLE (CEV)

OPTION 1

SCHEDULE B

**SECTION A**  
**OMB Approval 2700-0042**

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**AWARD/CONTRACT FORM**

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(END OF SECTION)

**PART I - THE SCHEDULE**

**SECTION B - SUPPLIES OR SERVICES AND PRICE/COSTS**

**B.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

**I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

**II. NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

(End of By Reference Section)

**B.2 DESCRIPTION OF WORK**

The contractor shall, in a manner consistent with and subject to the terms and conditions hereof, furnish all resources necessary except as otherwise provided in this contract, to manufacture, test, and deliver Crew Exploration Vehicles (CEV) that will carry human crews from Earth into space and back again. Coupled with transfer stages, landing vehicles, and surface exploration systems, the CEV will serve as an essential component of the architecture that supports human voyages to ISS, the Moon, and beyond. All work will be specifically authorized via delivery orders issued within the terms and conditions of this contract.

This contract is divided into three separate contract schedules (A, B, and C). Terms and conditions set forth in each contract schedule apply to that schedule only.

(End of clause)

**B.3 RESERVED**

(End of clause)

**B.4 FIXED PRICE INCENTIVE (NFS 1852.216-83) (OCT 1996) (Applicable only to fixed price delivery orders)**

The target cost of this contract is \$ TBD at delivery order issuance . The Target profit of this contract

is \$ TBD at delivery order issuance. The target price (target cost plus target profit) of this contract is \$ TBD at delivery order issuance. [The ceiling price is \$ TBD at delivery order issuance.]

The cost sharing for target cost underruns is:

Government TBD at delivery order issuance percent Contractor TBD at delivery order issuance percent.

The cost sharing for target cost overruns is:

Government TBD at delivery order issuance percent Contractor TBD at delivery order issuance percent

(End of clause)

**B.5 ESTIMATED COST AND INCENTIVE FEE (NFS 1852.216-84) (OCT 1996) (Applicable only to cost reimbursement)**

A target cost and target fee will be determined for each individual delivery order at the time of issuance.

The maximum fee is TBD at delivery order issuance.

The minimum fee is TBD at delivery order issuance.

The cost sharing for target cost underruns is:

Government TBD at delivery order issuance percent Contractor TBD at delivery order issuance percent.

The cost sharing for target cost overruns is:

Government TBD at delivery order issuance percent Contractor TBD at delivery order issuance percent

(End of clause)

**B. 6 LIMITATION OF FUNDS (FIXED-PRICE CONTRACT) (NFS 1852.232-77) (MAR 1989) (Applicable only to fixed price)**

- (a) Of the total price of items through TBD by NASA, the sum of \$ TBD by NASA is presently available for payment and allotted to this contract. It is anticipated that from time to time additional funds will be allocated to the contract in accordance with the following schedule, until the total price of said items is allotted:

SCHEDULE FOR ALLOTMENT OF FUNDS	
Date	Amounts

- (b) The Contractor agrees to perform or have performed work on the items specified in paragraph (a) of this clause up to the point at which, if this contract is terminated pursuant to the Termination for Convenience of the Government clause of this contract, the total amount payable by the Government

(including amounts payable for subcontracts and settlement costs) pursuant to paragraphs (f) and (g) of that clause would, in the exercise of reasonable judgment by the Contractor, approximate the total amount at the time allotted to the contract. The Contractor is not obligated to continue performance of the work beyond that point. The Government is not obligated in any event to pay or reimburse the Contractor more than the amount from time to time allotted to the contract, anything to the contrary in the Termination for Convenience of the Government clause notwithstanding.

- (c) (1) It is contemplated that funds presently allotted to this contract will cover the work to be performed until TBD by NASA.
- (2) If funds allotted are considered by the Contractor to be inadequate to cover the work to be performed until that date, or an agreed date substituted for it, the Contractor shall notify the Contracting Officer in writing when within the next 60 days the work will reach a point at which, if the contract is terminated pursuant to the Termination for Convenience of the Government clause of this contract, the total amount payable by the Government (including amounts payable for subcontracts and settlement costs) pursuant to paragraphs (f) and (g) of that clause will approximate 75 percent of the total amount then allotted to the contract.
- (3) (i) The notice shall state the estimate when the point referred to in paragraph (c)(2) of this clause will be reached and the estimated amount of additional funds required to continue performance to the date specified in paragraph (c)(1) of this clause, or an agreed date substituted for it.
- (ii) The Contractor shall, 60 days in advance of the date specified in paragraph (c)(1) of this clause, or an agreed date substituted for it, advise the Contracting Officer in writing as to the estimated amount of additional funds required for the timely performance of the contract for a further period as may be specified in the contract or otherwise agreed to by the parties.
- (4) If, after the notification referred to in paragraph (c)(3)(ii) of this clause, additional funds are not allotted by the date specified in paragraph (c)(1) of this clause, or an agreed date substituted for it, the Contracting Officer shall, upon the Contractor's written request, terminate this contract on that date or on the date set forth in the request, whichever is later, pursuant to the Termination for Convenience of the Government clause.
- (d) When additional funds are allotted from time to time for continued performance of the work under this contract, the parties shall agree on the applicable period of contract performance to be covered by these funds. The provisions of paragraphs (b) and (c) of this clause shall apply to these additional allotted funds and the substituted date pertaining to them, and the contract shall be modified accordingly.
- (e) If, solely by reason of the Government's failure to allot additional funds in amounts sufficient for the timely performance of this contract, the Contractor incurs additional costs or is delayed in the performance of the work under this contract, and if additional funds are allotted, an equitable adjustment shall be made in the price or prices (including appropriate target, billing, and ceiling prices where applicable) of the items to be delivered, or in the time of delivery, or both.

- (f) The Government may at any time before termination, and, with the consent of the Contractor, after notice of termination, allot additional funds for this contract.
- (g) The provisions of this clause with respect to termination shall in no way be deemed to limit the rights of the Government under the default clause of this contract. The provisions of this Limitation of Funds clause are limited to the work on and allotment of funds for the items set forth in paragraph (a) of this clause. This clause shall become inoperative upon the allotment of funds for the total price of said work except for rights and obligations then existing under this clause.
- (h) Nothing in this clause shall affect the right of the Government to terminate this contract pursuant to the Termination for Convenience of the Government clause of this contract.

(End of clause)

**B.7 CONTRACT FUNDING (NASA 1852.232-81) (JUN 1990) (Applicable only to cost reimbursement)**

- a. For purposes of payment of cost, exclusive of fee, in accordance with the Limitation of Funds clause in Section I, the total amount allotted by the Government Schedule B is an estimate for the period of performance TBD by NASA at Award.
- b. Schedule B contract funding summary:

	COST	FEE	TOTAL
Schedule B	*****	<u>TBD by NASA at Award</u>	*****

(End of clause)

**B.8 CEV SPACECRAFT PRODUCTION**

Delivery Orders will be negotiated and executed in accordance with clause H.23 Method of Placing Delivery Order. The following tables detail the Not To Exceed (NTE) unit price for CEV Production Spacecraft available to be ordered under Schedule B.

(End of clause)

**B.9 MINIMUM/MAXIMUM IDIQ POTENTIAL CONTRACT VALUE**

In accordance with I.8 INDEFINITE QUANTITY (b), the guaranteed minimum amount of work which may be required under this contract Schedule B, is 2 CEV and the maximum amount of work which may be required under this contract is 60 CEV. This amount includes both cost and fee. The maximum amount is an estimate and does not reflect an obligation of the Government. The Government's obligation hereunder shall be based on that specified in the delivery orders issued during the period of the contract.

(End of clause)

**B.10 NOT TO EXCEED VALUE FOR FULL MANIFEST DELIVERY ORDER**

Delivery Orders will be negotiated and executed in accordance with clause H.23 Method of Placing Delivery Order. Should the Government request a Delivery Order proposal in accordance with Clause H.23 for the full manifest contained in Attachment J-16, Integrated Project Schedule, Table J-16-1, "CEV Project Milestones, Schedules B & C," the resulting delivery order shall not exceed

\$ 3,528,360,771

\_(End of clause)

(END OF SECTION)

## SECTION C - DESCRIPTION/SPECIFICATION/WORK STATEMENT

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### ***Introduction***

This Statement of Work (SOW) defines the work to be accomplished by the Contractor in the production of the CEV Spacecraft, modules, subsystems, and components over the life of the CEV contract. The CEV Production contractor shall accomplish the objectives and outcomes described within this contract. The contractor shall perform the services and deliver the products described in this SOW, contract terms and conditions, applicable documents, Data Requirements Descriptions (DRDs), and other plans and sections contained within this contract.

### ***Scope***

The Contractor will deliver CEV spacecraft configurations below per requirements in the CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD).

1. Block 1A is a crewed, pressurized vehicle for Low Earth Orbit (LEO) (including ISS crew change out) missions. This configuration includes a habitable Crew Module (CM), and a Launch Abort System (LAS) to provide a method for crew escape and abort. A Service Module (SM) will provide propulsion and translation capability.
2. Block 1B is an uninhabited, pressurized vehicle for ISS resupply missions. It uses an uninhabited CM and SM.
3. Block 2 is a crewed, pressurized vehicle for lunar missions. It uses a habitable CM, LAS and SM to support lunar missions.

## **1 Project Management**

The Contractor shall maintain and comply with the Project Management processes, systems and data deliverables utilized for all contract schedules (A, B and C) throughout the life of the contract. For Schedule B, the Contractor shall perform the appropriate project management functions:

- a) The Contractor shall maintain current DRDs and data deliverables as specified in Schedule A.

- b) The Contractor shall continue management activities using the same processes established in Schedule A.
- c) The Contractor shall follow the applicable standards, documents, requirements and processes as specified in Schedule A.

## **2 Systems Engineering and Integration**

### **2.1 Crosscutting Systems Engineering and Integration Development Activities**

#### **2.1.1 Systems Engineering Management**

Systems Engineering Management consists of the efforts to manage the Contractor's systems engineering and integration activities and to manage the Contractor's participation in NASA-led Constellation systems engineering and integration activities in accordance with NASA requirements and the Contractor's documented plans.

- a) The Contractor shall comply with their plans for managing technical data products, processes and organizational roles and responsibilities used to accomplish their systems engineering and integration activities per the Contractor's *CEV Prime Project Management Plan (DRD CEV-M-001)*.

#### **2.1.2 Integrated Models and Simulations (Reserved)**

#### **2.1.3 Open Architecture (Reserved)**

#### **2.1.4 Software Engineering (Reserved)**

#### **2.1.5 System Analysis (Reserved)**

#### **2.1.6 Integrated Logistics Support (Reserved)**

#### **2.1.7 Systems Test Verification and Certification (Reserved)**

#### **2.1.8 Human Engineering (Reserved)**

#### **2.1.9 Specialty Engineering**

Specialty Engineering applies the crosscutting specialty engineering disciplines of materials and processes, electromagnetic compatibility, EEE parts, environments, to the CEV System.

- a) The Contractor shall apply specialty engineering throughout the life cycle of the CEV System.
- b) The Contractor's approach to incorporating the engineering specialties into the systems engineering process and the technical effort required shall be documented in **DRD CEV-M-001**, *CEV Prime Project Management Plan*.

### 2.1.9.1 Materials and Processes

- a) The Contractor shall ensure materials are selected, controlled, implemented and verified to be consistent with their intended usage environments.
- b) The Contractor shall select, treat, fabricate, inspect, test, and analyze materials of construction to ensure the safety and success of the CEV.
- c) The Contractor shall maintain and implement **DRD CEV-T-019, *Materials and Processes (M&P) Selection, Implementation, and Control Plan***, that tailors the requirements and applicable documents of JSC-49774A, Standard Manned Spacecraft Requirements for Materials and Processes indicating the degree of conformance and the method of implementation for each requirement, and providing rationale for any requirements altered or not implemented.
- d) The Contractor shall use the following applicable standards for Materials and Processes or demonstrate use of an equivalent standard:
  - o IPC/EIA J-STD-001, Performance Class 3 with Space Addendum (Requirements for Soldered Electrical and Electronic Assemblies)
  - o IPC-A-610, Acceptability of Electronic Assemblies - Performance Class 3
  - o JPR8080.5, E14, JSC Design and Procedural Standard, E-14, Electrical Wire Harness Acceptance Testing
  - o JPR8080.5, E24, JSC Design and Procedural Standard, E-24, Electrical Wire and Cable Acceptance Test

### ***Deliverables***

The Contractor shall maintain the following document(s):

- DRD CEV-T-019: Materials and Processes Selection, Implementation, and Control Plan
- DRD CEV-T-020: Materials Usage Agreements (MUA)
- DRD CEV-T-022: Materials Identification and Usage List (MIUL)
- DRD CEV-T-023: Nondestructive Evaluation Plan

### 2.1.9.2 Electromagnetic Compatibility (Reserved)

### 2.1.9.3 Electrical, Electronic, and Electromechanical (EEE) Parts

- a) The Contractor shall develop, update, and implement **DRD CEV-T-027, *EEE Parts Management and Implementation Plan for the CEV System***.
- b) The Contractor shall establish processes to control all aspects of EEE parts from part selection through testing and hardware fabrication and part failure analysis.
- c) The Contractor shall use the following applicable standards for EEE Parts:

- o JPR 8080.5, E7 JSC Design and Procedural Standards, Section E-7, Electrical Components – Restrictions on Use
- o JPR 8080.5, E22 JSC Design and Procedural Standards, Section E22, Ionizing Radiation Effects

***Deliverables***

The Contractor shall maintain the following document(s):

- DRD CEV-T-027: Electrical, Electronic, and Electromechanical Parts Management and Implementation Plan
- DRD CEV-T-028: As-Built EEE Parts List

**2.1.9.4 Environments (Reserved)**

**2.2 Systems Requirements Development and Integration (Reserved)**

**2.3 CEV Launch Vehicle Integration (Reserved)**

**3 Safety and Mission Assurance**

- a) The Contractor shall implement Constellation Safety and Mission Assurance (S&MA) requirements into the CEV Delivery Order (DO) for all CEV activities and products including manufacturing and test.
- b) The Contractor shall demonstrate and document compliance with requirements stated in the CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD) for safety, reliability, maintainability, supportability, manufacturability, hardware and software quality assurance, industrial safety, and environmental safety, requirements for all aspects for all of the CEV DO.
- c) The Contractor shall maintain and comply with **DRD CEV-S-001, Safety and Mission Assurance (S&MA) Plan**, which defines their organization including subcontractors, processes, required skills, tasks and products for the CEV DO.
- d) The Contractor shall provide S&MA representation for CEV System technical, operations and management forums, boards/panels and project reviews.
- e) The Contractor shall generate, document, analyze and incorporate lessons learned for incorporation into NASA's Lessons Learned database per **DRD CEV-S-001, Safety and Mission Assurance (S&MA) Plan**.
- f) The Contractor shall provide an S&MA evaluation of all waivers and deviations and changes with an emphasis on impacts to safety and mission success for all products and activities.

***Deliverables***

The Contractor shall maintain the following document(s):

- DRD CEV-S-001: Safety and Mission Assurance (S&MA) Plan

### **3.1 System Safety (Reserved)**

### **3.2 Industrial, Environmental, Processing Site, Launch Site and Range Safety**

- a) The Contractor shall provide immediate verbal notification (upon discovery) and a prompt written report (within 24 hours) any accident, incident, incident or exposure resulting in fatality, lost-time occupational injury, disease, contamination of property beyond any stated acceptable limits, or property loss of \$1,000 or more to the NASA Safety office and the Contracting Officer. The Contractor shall provide mishap and close calls and safety statistics including trend items per **DRD CEV-S-004, Mishap Plan and Safety Statistics**. The Contractor shall assist the NASA investigating authority, as requested, for these incidents.
- b) The Contractor shall furnish to NASA or its agent sufficient information and technical data to update NASA's National Environmental Policy Act (NEPA) analysis in accordance with NPR 8580.1, Implementing the National Environmental Policy Act and Executive Order 12114.
- c) The Contractor shall maintain an effective safety and health program, which identifies, eliminate, mitigates and control hazards and risks in all Contractor activities in accordance with the approved Safety and Health Plan and document the plan in **DRD CEV-S-008, Safety and Health Plan**.
- d) The Contractor shall ensure their subcontractors (if any) follow Occupational Safety and Health Administration (OSHA), NASA, and CEV safety and health requirements and document this "flow down" of safety and health responsibility in **DRD CEV-S-008, Safety and Health Plan**.
- e) The Contractor shall actively participate in Test Readiness Reviews to assure personnel and hardware safety.
- f) The Contractor shall maintain a list of all hazardous operations to be performed, and list of other major or key operations required or planned in the performance of the contract per **DRD CEV-S-006, Hazardous Key Operations List**.
- g) The Contractor shall update, maintain, and provide to NASA a mishap prevention plan per **DRD CEV-S-004, Mishap Plan and Safety Statistics**.

#### ***Deliverables***

The Contractor shall maintain the following document(s):

- DRD CEV-S-004: Mishap Plan and Safety Statistics
- DRD CEV-S-006: Hazardous, Key Operations List

### **3.3 Reliability, Maintainability, and Supportability (RMS)**

- a) The Contractor shall maintain and comply with the RMS Plan per **DRD CEV-S-001, Safety and Mission Assurance (S&MA) Plan**, which defines the implementation of RMS within their organization including processes, required skills, tasks and products for the CEV DO.

- b) The Contractor shall participate as a member in the Exchanging Parts, Materials, and Safety Problem Data Utilizing the Government Industry Data Exchange Program (GIDEP) and document per **DRD CEV-S-012**, *Government-Industry Data Exchange Program and NASA Advisories/ALERTS*.

***Deliverables***

The Contractor shall maintain the following document(s):

- **DRD CEV-S-012**: Government-Industry Data Exchange Program and NASA Advisors/ALERTS

**3.4 Hardware Quality Assurance**

- a) The Contractor shall maintain, and comply with the quality management system as documented in the Quality Assurance Plan per **DRD CEV-S-001**, *Safety and Mission Assurance (S&MA) Plan*, which ensures the performance of the SOW requirements and is in accordance with CXP-20006, Constellation Program Quality Document.
- b) The Contractor shall maintain and comply with the Problem Reporting and Corrective Action (PRACA) system and provide all reportable problems, their status, and corrective actions, for both hardware and software per **DRD CEV-S-013**, *Problem Reporting and Corrective Action (PRACA) Reports*.
- c) The Contractor shall identify, track, and disposition all hardware and software non-conformances, anomalies, and discrepancies in a Contractor database and provide NASA with access to these records, for the life of the project.
- d) The Contractor shall document the findings and the results of internal and subcontractor audits per **DRD CEV-S-014**, *Quality Assurance (QA) Audit Report*.
- e) The Contractor shall have an assurance activity review modified and/or updated design specifications and designs to determine compliance with required materials specifications.
- f) The Contractor shall have an assurance activity to review Materials and Special Processes activities in the CEV Spacecraft Manufacturing process, to assure compliance with materials and process control specifications (including welding and brazing assurance, and NDE expertise to assure proper methods, techniques and standards are being used in the performance of NDE upon the hardware).
- g) The Contractor shall update and comply with the controls that they will use for those manufacturing processes where uniform high quality cannot be ensured by inspection alone per **DRD CEV-S-015**, *Critical Processes*.
- h) The Contractor shall update and document changes to its workmanship standards/specifications to ensure compliance with applicable NASA and Program Standards per **DRD CEV-S-017**, *Workmanship Standards*.
- i) The Contractor shall assure proper mechanical parts control has been applied for flight and critical ground support equipment hardware per **DRD CEV-S-016**, *Mechanical Parts Management and Implementation Plan*.

- j) The Contractor shall update and if required, document changes to its workmanship standards/specifications to ensure that they meet or exceed applicable NASA and Program Standards: NASA-STD-8739.1 Conformal Coating and Staking of Printed Wire Boards, NASA-STD-8739.2 Workmanship Standard for Surface Mount Technology, NASA-STD-8739.3 Soldered Electrical Connections, IPC-2221A Generic Standard on Printed board Design, IPC-2222 Sectional Design Standard on Printed board Design, IPC-6011 Generic Performance Specification for Printed Boards, IPC-6012B Qualification and Performance Specification for Rigid Printed Boards. The Contractor's internal workmanship standards shall be used to the maximum possible extent. Where Contractors specifications do not meet or exceed the Applicable documents, justification must be provide prior to NASA approval of its use. (CEV-S-017, *Workmanship Standards*).

### ***Deliverables***

The Contractor shall maintain the following document(s):

- DRD CEV-S-013: Problem Reporting and Corrective Action (PRACA) Reports
- DRD CEV-S-014: Quality Assurance (QA) Audit Report
- DRD CEV-S-015: Critical Processes
- DRD CEV-S-016: Mechanical Parts Management and Implementation Plan
- DRD CEV-S-017: Workmanship Standards

### ***3.5 Software Safety and Assurance (Reserved)***

**4 Reserved**

**5 Reserved**

**6 Spacecraft**

- a) The Contractor shall assemble/produce, and deliver CEV spacecraft subsystem hardware complying with all requirements in CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD) (including the listed applicable documents and those included in this SOW).

### ***6.1 Spacecraft Systems Engineering (Reserved)***

#### **6.1.1 Requirements Definition and Management (Reserved)**

#### **6.1.2 Spacecraft Integration (Reserved)**

#### **6.1.3 Spacecraft Crew Cabin and Cockpit Layout Design Requirements (Reserved)**

#### **6.1.4 Spacecraft Test, Verification, and Certification**

- a) The Contractor shall maintain and execute the *Acceptance Test Procedures* per **DRD CEV-T-039** for the acceptance of the CEV Spacecraft System, modules, subsystems, and components.
- b) The Contractor shall perform acceptance testing at the spacecraft, module, and component level and document the results using **DRD CEV-T-040, *Acceptance Data Package***. An Acceptance Data Package shall be produced for the spacecraft. An Acceptance Data Package shall be produced for each module. An Acceptance Data Package shall be produced for each component.

### ***Deliverables***

The Contractor shall deliver and maintain the following document(s):

- DRD CEV-T-039: Acceptance Test Procedures
- DRD CEV-T-040: Acceptance Data Package

## **6.1.5 Spacecraft Specialty Engineering (Reserved)**

### **6.2 *Spacecraft Subsystems***

- a) The Contractor shall assemble/produce and deliver all spacecraft subsystems to the component level. A small number of subsystems contain Government Furnished Products. These NASA provided products will be detailed in each subsystem section.

#### **6.2.1 Avionics**

- a) The Contractor shall perform 400 hours burn-in testing on each avionics Line Replaceable Unit (LRU) to screen out early hardware failures.

##### **6.2.1.1 Flight Software (Reserved)**

##### **6.2.1.2 Command & Data Handling (C&DH) (Reserved)**

##### **6.2.1.3 Communications and Tracking (C&T) (Reserved)**

##### **6.2.1.4 Displays & Controls (Reserved)**

#### **6.2.2 Electrical Power Subsystem (Reserved)**

#### **6.2.3 Mechanisms**

- a) NASA will provide the Low Impact Docking System (LIDS) and associated data products.



**6.2.4 Passive Thermal Control (Reserved)**

**6.2.5 Thermal Protection System (Reserved)**

**6.2.6 Structures (Reserved)**

**6.2.7 Propulsion (Reserved)**

**6.2.8 Suits, EVA, and Survival Crew Equipment Support Systems**

- a) NASA will provide the CEV suits and Extra Vehicular Activity (EVA) support equipment (e.g., EVA suits, launch and entry suits, helmets, gloves, undergarments, and standard EVA tools if applicable).
- b) NASA will provide crew equipment systems and gear for emergency egress and survival, crew/personnel postlanding tracking systems, and crew/personnel postlanding communications systems.
- c) The Contractor shall perform assembly/production and delivery of the CEV interfaces for the NASA-provided suits, EVA support equipment, and survival crew equipment as defined in CXP-01009, CEV to Suits, Extra Vehicular Activity (EVA) and Crew Survival Equipment External IRD.

**6.2.9 Environmental Control and Life Support (ECLS), Crew Health, and Habitation Accommodations (Reserved)**

**6.2.10 Pyrotechnics**

- a) NASA will supply the pyrotechnic initiators for all pyrotechnic events excluding non-Shuttle mechanically initiated devices for crew escape. NASA will supply interface and performance requirements for the system used to fire the initiators.
- b) If the Contractor selects existing Shuttle pyrotechnic initiator devices for the CEV Spacecraft, then NASA will supply those pyrotechnic initiator devices to the Contractor.
- c) NASA will supply all pyrotechnic initiators used on the parachute system.

**6.2.11 Landing and Recovery System**

- a) NASA will provide the parachute system.

**6.2.12 Guidance, Navigation, and Control (GN&C) (Reserved)**

**6.2.13 Wiring**

- a) The Contractor shall manufacture/fabricate and deliver all vehicle wiring in accordance with **DRD CEV-T-079, CEV Wiring Plan**, and **DRD CEV-T-080, CEV Wiring Database and Reports**.

**6.2.14 Launch Abort System (Reserved)**

**6.3 Government Provided Products (Reserved)**

**6.4 Spacecraft Integration and Test Facilities (Reserved)**

**6.5 Spacecraft Assembly, Integration, and Production**

- a) The Contractor shall integrate, assemble, certify, acceptance test, and deliver flight spacecraft meeting the requirements for the particular configurations below.
- b) The Contractor shall test (acceptance test only) and deliver flight spares in accordance with **DRD CEV-T-012, Logistics Support Analysis (Recommended Spare Parts List)**.
- c) The Contractor shall maintain and implement the plans for transportation of the CEV spacecraft to the processing site and/or launch site. These plans shall be included in **DRD CEV-T-087, CEV Spacecraft Handling and Transportation Plan**.
- d) The Contractor shall provide imagery (e.g., still photo, motion picture, digital imagery, or video) of the CEV spacecraft system, modules, subsystems, and components during manufacturing, assembly, test, integration, and close-out to document the hardware configuration per **DRD CEV-T-088, CEV Imagery Plan/Imagery Deliverables**.
- e) The Contractor shall maintain and implement a plan to manufacture (including the Contractor's plans for design for manufacturability) and assemble the flight articles(s) and associated unique tooling, fixtures and support and test equipment in accordance with **DRD CEV-T-086, Manufacturing and Assembly Plan**.
- f) The Contractor shall deliver the CEV spacecraft per the CEV DO and associated Acceptance Data Packages identified in **DRD CEV-T-040, Acceptance Data Package**.

***Deliverables***

The Contractor shall maintain the following document(s):

- DRD CEV-T-040: Acceptance Data Package
- DRD CEV-T-086: Manufacturing and Assembly Plan
- DRD CEV-T-087: CEV Handling and Transportation Plan
- DRD CEV-T-088: CEV Imagery Plan/Imagery Deliverables

**7 Operations (Reserved)**

**8 Launch and Vehicle Services (Reserved)**

**9 Ground and Training Systems (Reserved)**

**10 Flight Test (Reserved)**

(END OF SECTION)

## SECTION D - PACKAGING AND MARKING

### D.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

#### I. **FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

#### II. **NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

(End of By Reference Section)

### D.2 PACKAGING, HANDLING, AND TRANSPORTATION (NASA 1852.211-70) (SEP 2005)

- (a) The Contractor shall comply with NASA Procedural Requirements (NPR) 6000.1, "Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components", as may be supplemented by the statement of work or specifications of this contract, for all items designated as Class I, II, or III.
- (b) The Contractor's packaging, handling, and transportation procedures may be used, in whole or in part, subject to the written approval of the Contracting Officer, provided (1) the Contractor's procedures are not in conflict with any requirements of this contract, and (2) the requirements of this contract shall take precedence in the event of any conflict with the Contractor's procedures.
- (c) The Contractor must place the requirements of this clause in all subcontracts for items that will become components of deliverable Class I, II, or III items.

(End of clause)

(END OF SECTION)

**SECTION E - INSPECTION AND ACCEPTANCE**

**E.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

**I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

CLAUSE NUMBER	DATE	TITLE
52.246-2	AUG 1996	INSPECTION OF SUPPLIES-FIXED-PRICE (ALT 1) (JUL 1985) ( <i>Applicable only to fixed price</i> )
52.246-3	MAY 2001	INSPECTION OF SUPPLIES - COST REIMBURSEMENT ( <i>Applicable only to cost reimbursement</i> )
52.246-7	AUG 1996	INSPECTION OF RESEARCH AND DEVELOPMENT-FIXED-PRICE ( <i>Applicable only to fixed price</i> )
52.246-8	MAY 2001	INSPECTION OF RESEARCH AND DEVELOPMENT-COST-REIMBURSEMENT( <i>Applicable only to cost reimbursement</i> )
52.246-16	APR 1984	RESPONSIBILITY FOR SUPPLIES ( <i>Applicable only to fixed price</i> )

**II. NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

CLAUSE NUMBER	DATE	TITLE
1852.246-73	MAR 1997	HUMAN SPACE FLIGHT ITEM

(End of By Reference Section)

**E.2 HIGHER-LEVEL CONTRACT QUALITY REQUIREMENT (FAR 52.246-11) (FEB 1999)**

The contractor shall comply with the higher-level quality standard selected below:

SAE AS9100, Quality Systems-Aerospace, model for Quality Assurance in Design, Development, Production, Installation and Servicing

(End of clause)

**E.3 MATERIAL INSPECTION AND RECEIVING REPORT (1852.246-72) (AUG 2003)**

- (a) At the time of each delivery to the Government under this contract, the Contractor shall furnish a Material Inspection and Receiving Report (DD Form 250 series) prepared in six (including original) copies, an original and five copies.
- (b) The Contractor shall prepare the DD Form 250 in accordance with NASA FAR Supplement 1846.6 . The Contractor shall enclose the copies of the DD Form 250 in the package or seal them in a waterproof envelope, which shall be securely attached to the exterior of the package in the most protected location.
- (c) When more than one package is involved in a shipment, the Contractor shall list on the DD Form 250, as additional information, the quantity of packages and the package numbers. The Contractor shall forward the DD Form 250 with the lowest numbered package of the shipment and print the words "CONTAINS DD FORM 250" on the package.

(End of clause)

**E.4 PRELIMINARY INSPECTION AT SOURCE AND FINAL INSPECTION AND ACCEPTANCE AT DESTINATION (JSC 52.246-91) (JUN 1991)**

Preliminary inspection for compliance with the contract specifications and requirements may be performed at origin by an authorized representative of the Government, and final inspection and acceptance will be performed by the contracting officer or his/her authorized representative at the destination.

(End of clause)

(END OF SECTION)

**SECTION F – DELIVERIES OR PERFORMANCE**

**F.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

**I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

CLAUSE NUMBER	DATE	TITLE
52.242-15	AUG 1989	STOP-WORK ORDER ( <i>Applicable only to fixed price</i> ) (ALT I) (APR 1984) ( <i>Applicable only to cost reimbursement</i> )
52.247-29	FEB 2006	F.O.B. ORIGIN

**II. NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

CLAUSE	DATE	TITLE
None		

(End of By Reference Section)

**F.2 RESERVED**

(End of clause)

**F.3 BILLS OF LADING (NFS 1852.247-73) (JUN 2002)**

The purpose of this clause is to define when a commercial bill of lading or a government bill of lading is to be used when shipments of deliverable items under this contract are Free On Board (F.O.B.) origin.

- (a) Commercial Bills of Lading. All domestic shipments shall be made via commercial bills of lading (CBLs). The Contractor shall prepay domestic transportation charges. The Government shall reimburse the Contractor for these charges if they are added to the invoice as a separate line item supported by the paid freight receipts. If paid receipts in support of the invoice are not obtainable, a statement as described below must be completed, signed by an authorized company representative, and attached to the invoice. "I certify that the shipments identified below have been made, transportation charges have been paid by (company name), and paid freight or comparable receipts are not obtainable.

Contract or Order Number: NNJ06TA25C  
Destination: TBD."

- (b) Government Bills of Lading.

- (1) International (export) and domestic overseas shipments of items deliverable under this contract shall be made by Government bills of lading (GBLs). As used in this clause, "domestic overseas" means non-continental United States, i.e. Hawaii, Commonwealth of Puerto Rico, and possessions of the United States.
- (2) At least 15 days before shipment, the Contractor shall request in writing GBLs from: Cindy Ratliff, Lead TMS, Contract Transportation, 2101 NASA Parkway, Mail Code JB7, Houston, TX, 77058. If time is limited, requests may be by telephone: 281-483-3208. Requests for GBLs shall include the following information.
  - (i) Item identification/ description.
  - (ii) Origin and destination.
  - (iii) Individual and total weights.
  - (iv) Dimensional Weight.
  - (v) Dimensions and total cubic footage.
  - (vi) Total number of pieces.
  - (vii) Total dollar value.
  - (viii) Other pertinent data.

(End of clause)

**F.4 FLIGHT ITEM (JSC 52.247-95) (SEP 1989)**

Block 16 of each Department of Defense Form 250 prepared for hardware or equipment to be shipped under this contract must be annotated as follows in 1/4-inch letters or larger by hand printing or rubber stamp:

"THIS IS A FLIGHT ITEM: OR "THIS IS MISSION ESSENTIAL GROUND SUPPORT EQUIPMENT," as applicable.

(End of clause)

**F.5 SHIPPING INSTRUCTIONS**

All documentation and hardware to be shipped to JSC shall be shipped as identified below:

**Parcel Post Shipments and Freight Shipments**

Ship to: Transportation Officer,  
Building 421  
NASA Johnson Space Center  
2101 NASA Parkway  
Houston, TX 77058-3696

Mark for: Accountable Property Officer

Mark With: Contract Number NNJ06TA25C

For reissue to: (Name) Fred Ouellette  
(Mail Code) ZV  
(Bldg.) 17  
(Rm.) 252F

Hardware may be required to be shipped to locations other than those identified above in the performance of this contract; the “ship to; mark for; for reissue to” information shall be modified as necessary per delivery order to annotate the appropriate information for each shipment.

(End of clause)

**F.6 DELIVERABLES**

The Contractor shall make all deliverables as described in individual delivery orders and Section C, Attachment J-2, Data Requirements Description, of this contract.

(End of clause)

**F.7 OPTION TO EXTEND ORDERING PERIOD**

The Contracting Officer may exercise each of the options listed below by issuance of a unilateral contract modification 30 days or more before the end of the ordering period set forth in the “Ordering” clause. Should the option(s) be exercised, the resultant contract will include all terms and conditions of the contract as it exists immediately prior to the exercise of the option(s), except for the following changes:

1. Clause B.8 entitled “CEV Spacecraft Production” shall be extended through the year 2019.
2. Part (a) of clause I.6 entitled “Ordering” shall be changed to show that orders may be issued from September 8, 2009 through September 7, 2019.

(End of clause)

**F.8 DELIVERY ORDER TYPE**

Delivery orders may be fixed-price, fixed-price incentive or cost reimbursement. Clauses applicable to cost reimbursement and fixed-price are contained within this contract schedule. The appropriate clauses (either cost reimbursement or fixed-price) within the contract will apply to a delivery order based on the type of order issued (cost reimbursement or fixed-price).

(End of clause)

(END OF SECTION)



**SECTION G - CONTRACT ADMINISTRATION DATA**

**G.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

**I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

CLAUSE NUMBER	DATE	TITLE
None		

**II. NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

CLAUSE NUMBER	DATE	TITLE
1852.227-70	MAY 2002	NEW TECHNOLOGY
1852.227-86	DEC 1987	COMMERCIAL COMPUTER SOFTWARE— LICENSING
1852.242-71	DEC 1988	TRAVEL OUTSIDE OF THE UNITED STATES <i>(Applicable only to cost reimbursable)</i>
1852.242-73	JUL 2000	NASA CONTRACTOR FINANCIAL MANAGEMENT REPORTING
1852.245-70	JUL 1997	CONTRACTOR REQUESTS FOR GOVERNMENT OWNED EQUIPMENT
1852.245-72	MAR 1989	LIABILITY FOR GOVERNMENT PROPERTY FURNISHED FOR REPAIR OR OTHER SERVICES <i>(Applicable only to fixed price)</i>
1852.245-73	OCT 2003	FINANCIAL REPORTING OF NASA PROPERTY IN THE CUSTODY OF CONTRACTORS (In Paragraph b(3), the NASA office for receipt of NF1018 is: LF631/ Property Accounting and JB3/Property Administrator, 2101 NASA Parkway, Houston, TX 77058)

(End of By Reference Section)

**G.2 SECURITY/BADGING REQUIREMENTS FOR FOREIGN NATIONAL VISITORS  
AND EMPLOYEES/REPRESENTATIVES OF FOREIGN CONTRACTORS. (JSC  
52.204-91) (JAN 2006)**

- (a) An employee of a domestic Johnson Space Center (JSC) contractor or its subcontractor who is not a U.S. citizen (foreign national) may not be admitted to the JSC site for purposes of performing work without special arrangements. In addition, all employees or representatives of a foreign JSC contractor/subcontractor may not be admitted to the JSC site without special arrangements. For employees as described above, advance notice must be given to the Security Office of the host installation [JSC or White Sands Test Facility (WSTF)] at least 3 weeks prior to the scheduled need for access to the site so that instructions on obtaining access may be provided. Contractors should be aware that approval for access to the site and issuance of a badge may take much longer than three weeks and sufficient lead time must be allowed to accommodate the approval process.
- (b) All visit/badge requests for persons described in (a) above must be entered in the NASA Foreign National Management System (NFMMS) for acceptance, review, concurrence and approval purposes. When an authorized company official requests a JSC or WSTF badge for site access, he/she is certifying that steps have been taken to ensure that its contractor or subcontractor employees, visitors, or representatives will not be given access to export-controlled or classified information for which they are not authorized. The authorized company officials shall serve as the contractor's representative(s) in certifying that all visit/badge request forms are processed in accordance with JSC and WSTF security and export control procedures. No foreign national, representative, or resident alien contractor/subcontractor employee shall be granted access into JSC or WSTF until approved and processed through the NFMMS. Unescorted access will not be granted unless a favorable National Agency Check (NAC) has been completed by the JSC Security Office, and an approved NASA Foreign National Visitor Security/Technology Control Plan (STTCP), (previously called the Access Control Plan) has been submitted and approved.
- (c) The contractor agrees that it will not employ for the performance of work onsite at the JSC or WSTF any individuals who are not legally authorized to work in the United States. If the JSC or WSTF Industrial Security Specialist or the contracting officer has reason to believe that any employee of the contractor may not be legally authorized to work in the United States and/or on the contract, the contractor may be required to furnish copies of Form I-9 (Employment Eligibility Verification), U.S. Department of Labor Application for Alien Employment Certification, and any other type of employment authorization document.

The contractor agrees to provide the information requested by the JSC or WSTF Security Office in order to comply with NASA policy directives and guidelines related to foreign visits to NASA facilities so that (1) the visitor/employee/ representative may be allowed access to JSC or other NASA Centers for performance of this contract, (2) required investigations can be conducted, and (3) required annual or revalidation reports can be submitted to NASA Headquarters. All requested information must be submitted in a timely manner in accordance with instructions provided by JSC or any other Center to be visited.

(End of clause)

**G.3 SUBMISSION OF VOUCHERS FOR PAYMENT (NASA 1852.216-87) (MAR 1998)**  
**(Applicable only to cost reimbursable)**

- (a) The designated billing office for cost vouchers for purposes of the Prompt Payment clause of this contract is indicated below. Public vouchers for payment of costs shall include a reference to the number of this contract.

- (b) (1) If the contractor is authorized to submit interim cost vouchers directly to the NASA paying office, the original voucher should be submitted to:

NASA Lyndon B. Johnson Space Center  
Attn: Mail Code LF231  
2101 NASA Parkway  
Houston, TX 77058

- (2) For any period that the Defense Contract Audit Agency has authorized the contractor to submit interim cost vouchers directly to the Government paying office, interim vouchers are not required to be sent to the Auditor, and are considered to be provisionally approved for payment, subject to final audit.

- (3) Two copies of vouchers should be submitted as directed by the Contracting Officer.

- (c) If the contractor is not authorized to submit interim cost vouchers directly to the paying office as described in paragraph (b), the contractor shall prepare and submit vouchers as follows:

- (1) One original Standard Form (SF) 1034, SF 1035, or equivalent contractor's attachment to:

Cognizant DCAA/DCMA Office

- (2) Five copies of SF 1034, SF 1035A, or equivalent contractor's attachment to the following offices by insertion in the memorandum block of their names and addresses:

- (i) Copy 1 NASA Contracting Officer
- (ii) Copy 2 Auditor
- (iii) Copy 3 Contractor
- (iv) Copy 4 Contract administration office; and
- (v) Copy 5 Project management office.

- (3) The Contracting Officer may designate other recipients as required.

- (d) Public vouchers for payment of fee shall be prepared similarly to the procedures in paragraphs (b) or (c) of this clause, whichever is applicable, and be forwarded to:

NASA Lyndon B. Johnson Space Center  
BT/Exploration Procurement Office  
Attn: Contract Specialist  
2101 NASA Parkway  
Houston, TX 77058

This is the designated billing office for fee vouchers for purposes of the Prompt Payment clause of this contract.

- (e) In the event that amounts are withheld from payment in accordance with provisions of this contract, a separate voucher for the amount withheld will be required before payment for that amount may be made.

(End of clause)

**G.4 SUBMISSION OF INVOICES (JSC 52.232-90) (OCT 1993) (Applicable only to fixed price)**

Invoices shall be prepared and submitted in quadruplicate unless otherwise specified. Invoices shall contain the following information as applicable: contract and order number, item numbers, description of supplies or services, sizes, quantities, unit prices, and extended totals. Invoices shall be submitted to:

NASA Johnson Space Center  
Attn: BT/Contracting Officer  
2101 NASA Parkway  
Houston, TX 77058-3696

In the event that amounts are withheld from payment in accordance with the New Technology Clause or other provisions of this contract, a separate invoice for the amount withheld will be required before payment for that amount may be made.

(End of clause)

**G.5 RESERVED**

(End of clause)

**G.6 DESIGNATION OF NEW TECHNOLOGY REPRESENTATIVE AND PATENT REPRESENTATIVE (NASA 1852.227-72) (JUL 1997)**

- (a) For purposes of administration of the clause of this contract entitled "New Technology" or "Patent Rights -- Retention by the contractor (Short Form)", whichever is included, the following named representatives are hereby designated by the Contracting Officer to administer such clause:

AT/Technology Transfer & Commercialization Office  
AL/Patent Representative  
NASA Lyndon B. Johnson Space Center  
2101 NASA Parkway  
Houston, TX 77058

- (b) Reports of reportable items, and disclosure of subject inventions, interim reports, final reports, utilization reports, and other reports required by the clause, as well as any correspondence with respect to such matters, should be directed to the New Technology Representative unless transmitted in response to correspondence or request from the Patent Representative. Inquiries

or requests regarding disposition of rights, election of rights, or related matters should be directed to the Patent Representative. This clause shall be included in any subcontract hereunder requiring a "New Technology" clause or "Patent Rights--Retention by the contractor (Short Form)" clause, unless otherwise authorized or directed by the Contracting Officer. The respective responsibilities and authorities of the above-named representatives are set forth in 1827.305-370 of the NASA FAR Supplement.

(End of clause)

**G.7 IDENTIFICATION OF EMPLOYEES. (JSC 52.242-92) (JAN 2006)**

At all times while on Government property, the contractor, subcontractors, their employees and agents shall wear badges which will be issued by the NASA Badging & Visitor Control Office, located in Building 110 at the Johnson Space Center (JSC), or at the Main Gate at the White Sands Test Facility (WSTF). JSC employee and visitor badges will be issued only between the hours of 6:00 a.m. to 7:30 p.m., Monday through Friday, and 7:00 am to 4:00 pm on Saturday and Sunday. WSTF employee badges will be issued only between the hours of 8 a.m. to 2 p.m., Monday through Friday. WSTF visitor badges will be issued on a 7-day a week, 24-hour a day basis. Resident aliens and foreign nationals/representatives shall be issued green foreign national badges.

Each individual who wears a badge shall be required to sign personally for the badge. The contractor shall be held accountable for issued badges and all other related items and must assure that they are returned to the NASA Badging & Visitor Control Offices upon completion of work under the contract in accordance with Security Management Directive (SMD) 500-15, "Security Termination Procedures." Failure to comply with the NASA contractor termination procedures upon completion of the work (e.g., return of badges, keys, CAA cards, clearance terminations, JSC Public Key Infrastructure (PKI)/special program deletions, etc.) may result in final payment being delayed.

(End of clause)

**G.8 INSTALLATION-ACCOUNTABLE GOVERNMENT PROPERTY (NFS 1852.245-71) (NOV 2004)**

- (a) The Government property described in the clause at 1852.245-77, List of Installation- Accountable Property and Services, shall be made available to the Contractor on a no-charge basis for use in performance of this contract. This property shall be utilized only within the physical confines of the NASA installation that provided the property. Under this clause, the Government retains accountability for, and title to, the property, and the Contractor assumes the following user responsibilities:

The contractor shall establish and adhere to a system of written procedures for compliance with these user responsibilities. Such procedures must include holding employees liable, when appropriate, for loss, damage, or destruction of Government property.

- (b) (1) The official accountable recordkeeping, physical inventory, financial control, and reporting of the property subject to this clause shall be retained by the Government and accomplished by the installation Supply and Equipment Management Officer (SEMO) and Financial Management

Officer. If this contract provides for the contractor to acquire property, title to which will vest in the Government, the following additional procedures apply:

- (i) The contractor's purchase order shall require the vendor to deliver the property to the installation central receiving area;
  - (ii) The contractor shall furnish a copy of each purchase order, prior to delivery by the vendor, to the installation central receiving area;
  - (iii) The contractor shall establish a record of the property as required by FAR 45.5 and 1845.5 and furnish to the Industrial Property Officer a DD Form 1149 Requisition and Invoice/Shipping Document (or installation equivalent) to transfer accountability to the Government within 5 working days after receipt of the property by the contractor. The contractor is accountable for all contractor-acquired property until the property is transferred to the Government's accountability.
  - (iv) Contractor use of Government property at an off-site location and off-site subcontractor use require advance approval of the contracting officer and notification of the SEMO. The contractor shall assume accountability and financial reporting responsibility for such property. The contractor shall establish records and property control procedures and maintain the property in accordance with the requirements of FAR Part 45.5 until its return to the installation.
- (2) After transfer of accountability to the Government, the contractor shall continue to maintain such internal records as are necessary to execute the user responsibilities identified in paragraph (a) and document the acquisition, billing, and disposition of the property. These records and supporting documentation shall be made available, upon request, to the SEMO and any other authorized representatives of the contracting officer.

(End of clause)

**G.9 LIST OF GOVERNMENT-FURNISHED PROPERTY (NASA 1852.245-76) (OCT 1988)**

For performance of work under this contract, the Government will make available Government property identified in Attachment J-11 of this contract on a no-charge-for-use basis. The contractor shall use this property in the performance of this contract. Under the FAR 52.245 Government property clause of this contract, the contractor is accountable for the identified property.

(End of clause)

**G.10 LIST OF INSTALLATION-ACCOUNTABLE PROPERTY AND SERVICES (NFS 1852.245-77) (JUL 1997)**

In accordance with the clause at 1852.245-71, Installation-Accountable Government Property, the Contractor is authorized use of the types of property and services listed below, to the extent they are available, in the performance of this contract within the physical borders of the installation which may

include buildings and space owned or directly leased by NASA in close proximity to the installation, if so designated by the Contracting Officer.

- (a) Office space, work area space, and utilities. Government telephones are available for official purposes only; pay telephones are available for contractor employees for unofficial calls.
- (b) General- and special-purpose equipment, including office furniture.
  - (1) Equipment to be made available is listed in Attachment J-10. The Government retains accountability for this property under the clause at 1852.245-71, Installation-Accountable Government Property, regardless of its authorized location.
  - (2) If the Contractor acquires property, title to which vests in the Government pursuant to other provisions of this contract, this property also shall become accountable to the Government upon its entry into Government records as required by the clause at 1852.245-71, Installation-Accountable Government Property.
  - (3) The Contractor shall not bring to the installation for use under this contract any property owned or leased by the Contractor, or other property that the Contractor is accountable for under any other Government contract, without the Contracting Officer's prior written approval.
- (c) Supplies from stores stock.
- (d) Publications and blank forms stocked by the installation.
- (e) Safety and fire protection for Contractor personnel and facilities.
- (f) Installation service facilities: See Attachment J-10
- (g) Medical treatment of a first-aid nature for Contractor personnel injuries or illnesses sustained during on-site duty.
- (h) Cafeteria privileges for Contractor employees during normal operating hours.
- (i) Building maintenance for facilities occupied by Contractor personnel.
- (j) Moving and hauling for office moves, movement of large equipment, and delivery of supplies. Moving services shall be provided on-site, as approved by the Contracting Officer.
- (k) The user responsibilities of the Contractor are defined in paragraph (a) of the clause at 1852.245-71, Installation-Accountable Government Property.

(End of clause)

(END OF SECTION)

## SECTION H - SPECIAL CONTRACT REQUIREMENTS

### H.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

#### I. **FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

CLAUSE NUMBER	DATE	TITLE
None		

#### II. **NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

CLAUSE NUMBER	DATE	TITLE
1852.208-81	NOV 2004	RESTRICTIONS ON PRINTING AND DUPLICATING
1852.223-70	APR 2002	SAFETY AND HEALTH
1852.223-75	FEB 2002	MAJOR BREACH OF SAFETY OR SECURITY
1852.223-76	JUL 2003	FEDERAL AUTOMOTIVE STATISTICAL TOOL REPORTING ( <i>Applicable only to cost reimbursable</i> )
1852.225-70	FEB 2000	EXPORT LICENSES (Insert "NASA facilities" in paragraph (b))
1852.228-76	DEC 1994	CROSS WAIVER OF LIABILITY FOR SPACE STATION ACTIVITIES
1852.242-72	AUG 1992	OBSERVANCE OF LEGAL HOLIDAYS (ALT II) (SEP 1989) (ALT I)(SEP 1989)
1852.244-70	APR 1985	GEOGRAPHIC PARTICIPATION IN THE AEROSPACE PROGRAM
1852.246-70	MAR 1997	MISSION CRITICAL SPACE SYSTEM PERSONNEL RELIABILITY PROGRAM

(End of By Reference Section)

#### H.2 REPRESENTATION, CERTIFICATION, AND OTHER STATEMENTS (JSC 52.209-90) (SEP 1988)

This contract incorporates Section K, Representations, Certifications, and Other Statements of Offerors, as set forth in the contractor's proposal number P06-460570 dated 21 July 2006 by reference, with the same force and effect as if it were given in full text.

(End of clause)



### **H.3 SPECIAL PROVISION FOR CONTRACT CHANGES**

The parties agree that, notwithstanding the provisions of the “Changes” clause and the “Government Property” clause, no change made pursuant to the “Changes” clause shall give rise to an equitable adjustment in the estimated cost or fee or any other contract provision when said change causes an increase or decrease of \$1,000,000 or less in the estimated cost of this contract. Each change shall be controlling in making this determination, and such change shall not, for purposes of determining the applicability of this clause, be added to any other change(s). The parties recognize that several changes may be grouped together in a bilateral modification for definitization; however, the dollar value of each individual change will be controlling in determining whether or not an equitable adjustment is in order.

(End of clause)

### **H.4 SUBCONTRACTING WITH RUSSIAN ENTITIES FOR GOODS OR SERVICES**

(a) Definitions: In this provision:

i) The term “Russian entities” includes the following:

- (1) The Russian Federal Space Agency (Roscosmos),
- (2) Any organization or entity under the jurisdiction or control of Roscosmos, or
- (3) Any other organization, entity, or element of the Government of the Russian Federation.

ii) The term “Organization or entity under the jurisdiction or control of Roscosmos” means an organization or entity that:

- (1) Was made part of the Russian Federal Space Agency upon its establishment on February 25, 1992;
- (2) Was transferred to the Russian Federal Space Agency by decree of the Russian Government on July 25, 1994, or May 12, 1998;
- (3) Was or is transferred to the Russian Aviation and Space Agency or Russian Federal Space Agency by decree of the Russian Government at any other time before, on, or after March 14, 2000; or
- (4) Is a joint stock company in which the Russian Aviation and Space Agency or Russian Federal Space Agency has at any time held controlling interest.

iii) The term “extraordinary payments” means payments in cash or in kind made or to be made by the United States Government prior to January 1, 2012, for work to be performed or services to be rendered prior to that date necessary to meet United States obligations under the Agreement Concerning Cooperation on the Civil International Space Station, with annex, signed at Washington January 29, 1998, and entered into force March 27, 2001, or any protocol, agreement, memorandum of understanding, or contract related thereto.

(b) This clause implements the Iran and Syria Nonproliferation Act (the Iran Nonproliferation Act as amended by the Iran Nonproliferation Amendments Act of 2005) to allow extraordinary payments prior to January 1, 2012 to Russian entities in connection with the International Space Station.

NASA has applied the restrictions in the Act to include funding of Russian entities via U.S. contractors.

- (c) (i) The Contractor shall not subcontract with Russian entities without first receiving written approval from the Contracting Officer. In order to obtain this written approval to subcontract with any Russian entity as defined in paragraphs (a), the Contractor shall provide the Contracting Officer with the following information related to each planned new subcontract and any change to an existing subcontract with entities that fit the description in paragraphs (a):

- (1) A detailed description of the subcontracting entity, including its name, address, and a point of contact, as well as a detailed description of the proposed subcontract including the specific purpose of payments that will be made under the subcontract.
- (2) The contractor shall provide certification that the subcontracting entity is not on any of the denied parties, specially designated nationals and entities of concern lists found at:  
<http://www.hq.nasa.gov/office/oer/nasaecp/Welcome.html>

**Denied Parties, Specially Designated Nationals and Entities of Concern**

BIS's Listing of Entities of Concern UPDATED

BIS's List of Denied Parties UPDATED

Debarred Parties Listing

OFAC's List of Specially Designated Nationals *(Adobe PDF format)*

List of Unverified Persons in Foreign Countries UPDATED

- (ii) Unless relief is granted by the Contracting Officer, the information necessary to obtain approval to subcontract shall be provided to the Contracting Officer 30 business days prior to executing any planned subcontract with entities defined in paragraph (a).
- (d) After receiving approval to subcontract, the contractor shall provide the Contracting Officer with a report every six-months which documents the individual extraordinary payments made to an entity in paragraph a. The reports are due on July 15<sup>th</sup> and January 15<sup>th</sup>. The July 15<sup>th</sup> report should document all of the individual extraordinary payments made from the previous January through June. The January 15<sup>th</sup> report should document all of the individual extraordinary payments made from the previous July through December. The content of the report shall provide the following information for each time an extraordinary payment is made to an entity in paragraph a:
- (i) The name of the entity
  - (ii) The subcontract number
  - (iii) The amount of the payment
  - (iv) The date of the payment
- (e) The Contracting Officer may direct the Contractor to provide additional information for any other prospective or existing subcontract at any tier. The Contracting Officer may direct the Contractor to terminate for the convenience of the government any subcontract at any tier with an entity described in paragraphs (a), subject to an equitable adjustment.

- (f) Notwithstanding FAR 52.216-7, "Allowable Cost and Payments," on or after January 1, 2012 the contractor shall be responsible to make payments to entities defined in paragraphs (a) of this provision. Any subcontract with entities defined in paragraph (a), therefore, should be completed in sufficient time to permit the U.S. Government to make extraordinary payments on subcontracts with Russian entities on or before December 31, 2011.
- (g) The Contractor shall include the substance of this clause in all its subcontracts, and shall require such inclusion in all other subcontracts of any tier. The Contractor shall be responsible to obtain written approval from the Contracting Officer to enter into any tier subcontract that involves entities defined in paragraph (a).

(End of clause)

#### **H.5 COMPLIANCE WITH APPLICABLE CENTER POLICIES AND PROCEDURES**

Contractor and subcontractor personnel (regardless of tier) working on-site at NASA Centers shall comply with all applicable center policies and procedures. The contractor shall keep itself and pertinent subcontractors up-to-date with the latest revisions of these policies and procedures. The contractor shall promptly take corrective action upon receipt of notice from the Contracting Officer of noncompliance with any applicable center policy or procedure.

(End of clause)

#### **H.6 RESERVED**

(End of clause)

#### **H.7 INDEMNIFICATION FOR UNUSUALLY HAZARDOUS RISKS**

a) The Government recognizes that the Contractor's approach to fulfill the requirements of this contract might involve conditions considered to constitute unusually hazardous risks resulting in potential third party liability exceeding insurance coverage the Contractor could reasonably be expected to purchase and maintain, considering the availability, cost, and terms and conditions of such insurance. In the event the Contractor believes such conditions exist and necessitate indemnification by the Government, the Contractor shall provide documentation and rationale adequate to substantiate processing of such requests in accordance with applicable laws and regulations. The Contractor shall furnish the information required in accordance with FAR 50.403-1 and NASA FAR Supplement 1850.403. Reference to these FAR and NASA FAR Supplement sections is not an indication that NASA has determined indemnification to be applicable. The Contractor's request for indemnification must explain under what authority NASA can provide indemnification for unusually hazardous risks associated with performance of the contract. In addition to identifying a sufficient legal basis for indemnification, the Contractor's request for indemnification also must substantiate a sufficient factual basis for indemnification by explaining specifically what work under the contract poses unusually hazardous risks.

b) The Government will consider a request for indemnification for unusually hazardous risks in accordance with the foregoing paragraph. In the event the Government denies the Contractor's request for indemnification, the parties will enter into good faith negotiations to determine the appropriate course of action concerning potential third party liability.

(End of clause)

**H.8 RESERVED**

(End of clause)

**H.9 RESERVED**

(End of clause)

**H.10 PATENT RIGHTS**

This contract includes the New Technology Clause 1852.227-70. It is anticipated that the Contractor may have Contractor background inventions that could be applied to Contract research and incorporated into deliverables under the Contract. The Government may need rights to use such Contractor background inventions in order to practice technologies produced under this Contract in other Government contracts. Thus, Contracting Officer permission is required before Contractor background inventions may be included in Contract deliverables. To the extent a contractor background invention has been Federally funded, the Government will receive its government-purpose license rights to practice the background invention. Where there is no Federal funding of the background invention, the Contractor will identify to the Contracting Officer the rights that it proposes to grant the Government to use such invention in other Government contracts. The Government shall receive a government-purpose license to practice any contractor background invention where such Contracting Officer permission is not obtained prior to incorporating its background inventions into Contractor work. This clause or a clause substantially the same shall be included in all subcontracts at any tier.

(End of clause)

**H.11 RESERVED**

(End of clause)

**H.12 ELECTRONIC DATA ACCESS**

The Contractor shall implement and maintain an Electronic Data Access (EDA) with the Government utilizing web-enabled technology at the Unclassified, For Official Use Only (FOUO), and Contractor Proprietary levels during the CEV Phase 2 contract. The EDA shall establish and maintain the capability for access to the contracting management information system, working data, including subcontractor data, developed to support the management and engineering efforts of the project. The Government will provide a list of authorized personnel for full electronic access to the contractor's database after contract award. The Contractor's database shall be compatible with typical Government PC-based systems using the MS Office 2000 suite of applications (e.g. Word, Excel, PowerPoint, and Project) as well as Adobe Acrobat 7.0. The Contractor shall establish the aforementioned EDA system capable of fully supporting government access information within thirty (30) calendar days of contract start.

(End of clause)

### **H.13 SPACE FLIGHT MOTIVATION AWARENESS PROGRAM**

The Contractor shall establish a program for Space Flight Awareness (SFA). The Program's goals and objectives are to:

- Ensure every employee involved in human space flight is aware of the importance of their role in promoting safety, quality and mission success.
- Participation in NASA-Industry Space Flight Awareness Program.
- Increase awareness of the Human Space Flight Program accomplishments, milestones and objectives with a focus on safety and mission success.
- Conduct events and products that motivate and recognize the workforce, and enhance employee morale.
- Function as an internal communications team to disseminate key educational, program/management safety, quality, and mission success messages and themes.

(End of clause)

### **H.14 SMALL BUSINESS SUBCONTRACTING GOALS**

In meeting the intent of Small /Disadvantaged business participation under this contract, the Contractor agrees to flow down to all first-tier large business subcontractors, as percentages (with corresponding dollar amounts) of their total contract value the same socioeconomic goals agreed to under the prime Contractor subcontracting plan. The Contractor agrees to flow down the goals to other tier large business subcontractors.

(End of clause)

### **H.15 SUBCONTRACTOR SMALL BUSINESS REPORTING**

Contractor shall require first-tier large business subcontractors to report lower-tier Small Business Concern subcontracting dollars on a semi-annual basis. This reporting is conducted through the Electronic Subcontracting Reporting Systems (eSRS) located at <http://www.esrs.gov>.

(End of clause)

### **H.16 KEY PERSONNEL AND FACILITIES (NASA 1852.235-71) (MAR 1989)**

- (a) The personnel and/or facilities listed below (or specified in the contract Schedule) are considered essential to the work being performed under this contract. Before removing, replacing, or diverting any of the listed or specified personnel or facilities, the Contractor shall (1) notify the Contracting Officer reasonably in advance and (2) submit justification (including proposed substitutions) in sufficient detail to permit evaluation of the impact on this contract.
- (b) The Contractor shall make no diversion without the Contracting Officer's written consent; provided, that the Contracting Officer may ratify in writing the proposed change, and that ratification shall constitute the Contracting Officer's consent required by this clause.

- (c) The list of personnel and/or facilities (shown below or as specified in the contract Schedule) may, with the consent of the contracting parties, be amended from time to time during the course of the contract to add or delete personnel and/or facilities.

NAME

TITLE

[REDACTED]

[REDACTED]

(End of clause)

#### **H.17 ASSOCIATE CONTRACTOR AGREEMENTS**

- (a) In order to achieve the requirements of this contract, the Contractor shall establish, in conjunction with the CEV Project Office, the means for coordination and exchange of information with associate contractors. The information to be exchanged shall be that required by the contractors in the execution of their respective contract requirements. The associate contractors contemplated by this clause have not been established at the time of contract award, but will be added by contract modification to this paragraph as required. The associate contractors will supply other elements of the Constellation program, such as a launch vehicle, earth departure stage, or lunar surface access module.
- (b) The Contractor shall document agreements with other associate contractors described in (a) above via associate contractor agreements. The Government will not be a party in such associate contractor agreements. A copy of each such agreement shall be provided to the Contracting Officer. All costs associated with such agreements are included in the negotiated cost of this contract.
- (c) The contractor is not relieved of any contract requirements or entitled to any adjustments to the contract terms because of the failure to resolve a disagreement with an associate contractor. Liability for the improper disclosure of any proprietary data contained in or referenced by any agreement shall rest with the parties to the agreement, and not the Government.

(End of clause)

#### **H.18 DATA DELIVERABLE MARKING REQUIREMENTS FOR EXPORT CONTROL**

- (a) The contractor shall perform an export control assessment for all data deliverable items shown in Attachment J-2, Data Procurement Document.
- (b) If a product is determined to contain information controlled by the International Traffic in Arms Regulations, the following statement shall be included on the product cover page.

#### **International Traffic in Arms Regulations (ITAR) Notice**

This document contains information on paragraphs [list specific pages subject to ITAR control] falls under the purview of the U.S. Munitions List (USML), as defined in the International Traffic in Arms Regulations (ITAR), 22 CFR 120-130, and is export controlled. It shall not be transferred to foreign nationals in the U.S. or abroad, without specific approval of a knowledgeable NASA export control official, and/or unless an export license/license exemption is obtained/available from the United States Department of State. Violations of these regulations are punishable by fine, imprisonment, or both.

- (c) If a product is determined to contain information controlled by the Export Administration Regulations and which requires a license or exception prior to export, the following statement shall be included on the product cover page:

**Export Administration Regulations (EAR) Notice**

This document contains information on [list specific pages subject to the EAR] within the purview of the Export Administration Regulations (EAR), 15 CFR 730-744, and is export controlled. It may not be transferred to foreign nationals in the U.S. or abroad, without specific approval of a knowledgeable NASA export control official, and/or unless an export license/license exception is obtained/available from the Bureau of Industry and Security (BIS), United States Department of Commerce. Violations of these regulations are punishable by fine, imprisonment, or both.

- d) If a product has been determined to be suitable for public release, it shall be so labeled.

(End of clause)

**H.19 APPLICATION OF U.S. SPACE TRANSPORTATION POLICY**

All effort under this contract shall be consistent with the National Security Presidential Directive/NSPD-40 (U.S. Space Transportation Policy.)

(End of clause)

**H.20 COMPLIANCE WITH APPLICABLE ELECTRONIC AND INFORMATION TECHNOLOGY (EIT) POLICIES**

The contractor shall aid NASA CEV Project office in the preparation of Information Technology reporting and documentations. The contractor agrees to produce for NASA/CEV Project Office documents related to NPR 2810.1, Security of Information Technology. The contractor further agrees to aid NASA in documentation related to OMB circular A-11, Preparation, submission, and Execution of Budget; OMB A-130, Management of Federal Information; Exhibit 53, List of IT Costs and Budget Items; and Exhibit 300, capital Asset Plan Reports on Major IT Investments.

(End of clause)

**H.21 LIMITATION OF FUTURE CONTRACTING (NFS 1852.209-71) (DEC 1988)**

- (a) The Contracting Officer has determined that this acquisition may give rise to a potential organizational conflict of interest. Accordingly, the attention of prospective offerors is invited to FAR Subpart 9.5--Organizational Conflicts of Interest.

- (b) The nature of this conflict is the Contractor may be in a position to favor its own products and capabilities and may have an unfair competitive advantage.
- (c) The restrictions upon future contracting are as follows:
- (1) If the Contractor, under the terms of this contract, or through the performance of tasks pursuant to this contract, is required to develop specifications or statements of work that are to be incorporated into a solicitation, the Contractor shall be ineligible to perform the work described in that solicitation as a prime or first-tier subcontractor under an ensuing NASA contract. This restriction shall remain in effect for a reasonable time, as agreed to by the Contracting Officer and the Contractor, sufficient to avoid unfair competitive advantage or potential bias (this time shall in no case be less than the duration of the initial production contract). NASA shall not unilaterally require the Contractor to prepare such specifications or statements of work under this contract.
  - (2) To the extent that the work under this contract requires access to proprietary, business confidential, or financial data of other companies, and as long as these data remain proprietary or confidential, the Contractor shall protect these data from unauthorized use and disclosure and agrees not to use them to compete with those other companies.

(End of clause)

## **H.22 ADVANCE AGREEMENT FOR CONTRACTOR INVESTMENTS**

The parties agree that the contract might be partly based on corporate contributions/investment as specified in the proposal or as negotiated in the contract. Costs related to the Contractor's contributions or investments shall be reported under the contract as they are incurred, for purposes of tracking the Contractor's costs as well as the full costs of the project. The Contractor agrees that, should the Government's requirements change or should all or part of the work under the contract be terminated, all reported costs as well as unreported costs related to the Contractor's contributions and investment will be unallowable as part of any contract settlement.

(End of clause)

## **H.23 METHOD OF PLACING DELIVERY ORDERS**

Delivery Orders may be placed only by the contracting officer. Delivery Orders will be in writing on JSC Form 1429 or orally, followed by written confirmation. The Contractor may incur costs under this contract in performance of task orders and task order modifications issued in accordance with this clause. No other costs are authorized unless otherwise specified in the contract or expressly authorized by the Contracting Officer.

- (a) Prior to issuing a delivery order, the Contracting Officer shall provide the Contractor with the following data:
- 1) A description of the items to be ordered.
  - 2) Proposed acceptance criteria.
  - 3) A request for a plan from the Contractor to include the proposed delivery date, proposed payment milestones, appropriate proposed cost or price information, and any other information required to determine the reasonableness of the Contractor's proposal.



- (b) Within 30 calendar days after receipt of the Contracting Officer's request, the Contractor shall submit a plan conforming to the request.
- (c) After review and any necessary discussions, the Contracting Officer may issue a delivery order to the Contractor containing, as a minimum, the following:
  - (1) Delivery order number and contract number
  - (2) Item/items ordered, including quantity, unit price, and amount of each
  - (3) Date of order, and required delivery date
  - (4) Total amount
  - (5) Signature of the contracting officer.
- (d) The Contractor shall provide acknowledgment of receipt to the Contracting Officer within 5 calendar days after receipt of the delivery order.
- (e) If time constraints do not permit issuance of a fully defined delivery order in accordance with the procedures described in paragraphs (a) through (d), a delivery order which includes a ceiling price may be issued.
- (f) The Contracting Officer may amend orders in the same manner in which they were issued.
- (g) In the event of a conflict between the requirements of the delivery order and the Contractor's approved plan, the delivery order shall prevail.
- (h) During the performance of the Schedule B Production activities, the parties of this contract recognize and agree that Delivery Orders for the CEV spacecraft must be placed well in advance of the planned mission date. Therefore, the parties agree that the order for each CEV spacecraft to be delivered under this contract will be placed (i.e. ATP provided to the contractor) Not-Later-Than 30 months prior to the planned mission launch date. This assumes that the CEV spacecraft will be delivered to NASA 2 (two) months prior to the planned mission launch date.
- (i) The parties further agree that in the event a CEV spacecraft is required for a mission less than 30 months in the future, the Contractor will perform its best efforts to comply with the compressed schedule and that the parties agree to negotiate, by mutual agreement, any impacts resulting from the compressed production schedule.

(End of clause)

#### **H.24 ADVANCE AGREEMENT-- CHANGES**

Delivery order proposals (inclusive of profit), submitted in accordance with the "Method Of Placing Deliver Orders" clause of this contract, will not have values that exceed the Not-To-Exceed (NTE) values presented in Clause B.8 and B.10. Both parties also recognize conditions during performance of Schedule "A" may occur that impact the basis of estimate used to establish the values in B.8 and B.10. Since these impacts cannot be anticipated with any degree of certainty at this time, the parties agree that prior to the government's issuance of the first delivery order under Schedule B the contractor may submit a one-time request for adjustment of the NTE values in Clause B.8. The request for adjustment will be through submittal of a Contract Change Order (CCO) proposal in accordance with the Changes-

Cost Reimbursement Clause (FAR 52.243-2 in Section I). This change proposal must track to the original baseline used in the establishment of values listed in Clause B.8 and B.10; and be limited to the changes approved since contract award. Requests that include or are strictly for rates and factor adjustments are outside the scope of this clause. Changes that occur after this one time adjustment will be treated as separate actions in accordance with the changes clause.

(End of clause)





**PART II - CONTRACT CLAUSES**

**SECTION I - CONTRACT CLAUSES**

**I.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

**I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
52.202-1	JUL 2004	DEFINITIONS
52.203-3	APR 1984	GRATUITIES
52.203-5	APR 1984	COVENANT AGAINST CONTINGENT FEES
52.203-6	JUL 1995	RESTRICTIONS ON SUBCONTRACTOR SALES TO THE GOVERNMENT
52.203-7	JUL 1995	ANTI-KICKBACK PROCEDURES
52.203-8	JAN 1997	CANCELLATION, RESCISSION, AND RECOVERY OF FUNDS FOR ILLEGAL OR IMPROPER ACTIVITY
52.203-10	JAN 1997	PRICE OR FEE ADJUSTMENT FOR ILLEGAL OR IMPROPER ACTIVITY
52.203-12	JUN 2003	LIMITATION ON PAYMENTS TO INFLUENCE CERTAIN FEDERAL TRANSACTIONS
52.204-2	AUG 1996	SECURITY REQUIREMENTS
52.204-4	AUG 2000	PRINTING/COPYING DOUBLE SIDED ON RECYCLED PAPER
52.204-7	OCT 2003	CENTRAL CONTRACTOR REGISTRATION
52.204-9	JAN 2006	PERSONAL IDENTITY VERIFICATION OF CONTRACTOR PERSONNEL (Please see Attachment J-19 PIV Card Issuance Procedures)
52.209-6	JAN 2005	PROTECTING THE GOVERNMENT'S INTEREST WHEN SUBCONTRACTING WITH CONTRACTORS DEBARRED, SUSPENDED, OR PROPOSED FOR DEBARMENT
52.211-5	AUG 2000	MATERIAL REQUIREMENTS
52.211-15	SEPT 1990	DEFENSE PRIORITY AND ALLOCATION REQUESTS
52.215-2	JUNE 1999	AUDIT AND RECORDS--NEGOTIATION
52.215-8	OCT 1997	ORDER OF PRECEDENCE--UNIFORM CONTRACT FORMAT

52.215-10	OCT 1997	PRICE REDUCTION FOR DEFECTIVE COST OR PRICING DATA
52.215-12	OCT 1997	SUBCONTRACTOR COST OR PRICING DATA
52.215-14	OCT 1997	INTEGRITY OF UNIT PRICES
52.215-15	OCT 2004	PENSION ADJUSTMENTS AND ASSET REVERSIONS
52.215-18	JUL 2005	REVERSION OR ADJUSTMENT OF PLANS FOR POSTRETIREMENT BENEFITS (PRB) OTHER THAN PENSIONS
52.215-19	OCT 1997	NOTIFICATION OF OWNERSHIP CHANGES
52.215-21	OCT 1997	REQUIREMENTS FOR COST OR PRICING DATA OR INFORMATION OTHER THAN COST OR PRICING DATA—MODIFICATIONS (ALT II) (OCT 1997) (ALT III) (OCT 1997) Insert (d) Electronic media: <u>Microsoft Office ®</u>
52.216-7	DEC 2002	ALLOWABLE COST AND PAYMENT ( <i>Applicable only to cost reimbursable</i> )
52.216-10	MAR 1997	INCENTIVE FEE ( <i>Applicable only to cost reimbursable</i> )
52.219-8	MAY 2005	UTILIZATION OF SMALL BUSINESS CONCERNS
52.219-9	JUL 2005	SMALL BUSINESS SUBCONTRACTING PLAN (ALT II) (OCT 2001)
52.219-16	JAN 1999	LIQUIDATED DAMAGES--SUBCONTRACTING PLAN
52.219-25	OCT 1999	SMALL DISADVANTAGED BUSINESS PARTICIPATION PROGRAM- DISADVANTAGED STATUS AND REPORTING
52.222-1	FEB 1997	NOTICE TO THE GOVERNMENT OF LABOR DISPUTES
52.222-3	JUN 2003	CONVICT LABOR
52.222-4	JUL 2005	CONTRACT WORK HOURS AND SAFETY STANDARDS ACT-OVERTIME COMPENSATION
52.222-20	DEC 1996	WALSH-HEALEY PUBLIC CONTRACTS ACT
52.222-21	FEB 1999	PROHIBITION OF SEGREGATED FACILITIES
52.222-26	APR 2002	EQUAL OPPORTUNITY
52.222-35	DEC 2001	EQUAL OPPORTUNITY FOR SPECIAL DISABLED VETERANS, VETERANS OF THE VIETNAM ERA, AND OTHER ELIGIBLE VETERANS
52.222-36	JUN 1998	AFFIRMATIVE ACTION FOR WORKERS WITH DISABILITIES
52.222-37	DEC 2001	EMPLOYMENT REPORTS ON SPECIAL DISABLED VETERANS, VETERANS OF THE VIETNAM ERA, AND OTHER ELIGIBLE VETERANS

52.222-39	DEC 2004	NOTIFICATION OF EMPLOYEE RIGHTS CONCERNING PAYMENT OF UNION DUES OR FEES
52.223-3	JAN 1997	HAZARDOUS MATERIAL IDENTIFICATION AND MATERIAL SAFETY DATA (ALT I) (JUL 1995) ( <i>Insert NONE in paragraph b</i> )
52.223-5	AUG 2003	POLLUTION PREVENTION AND RIGHT-TO-KNOW INFORMATION, (ALT I)(AUG 2003), (ALT II)(AUG 2003)
52.223-6	MAY 2001	DRUG-FREE WORKPLACE
52.223-14	AUG 2003	TOXIC CHEMICAL RELEASE REPORTING
52.224-1	APR 1984	PRIVACY ACT
52.225-5	JAN 2005	TRADE AGREEMENTS
52.225-8	FEB 2000	DUTY-FREE ENTRY
52.225-13	MAR 2005	RESTRICTIONS ON CERTAIN FOREIGN PURCHASES
52.227-1	JUL 1995	AUTHORIZATION AND CONSENT (ALT I) (APR 1984)
52.227-2	AUG 1996	NOTICE AND ASSISTANCE REGARDING PATENT AND COPYRIGHT INFRINGEMENT
52.227-16	JUN 1987	ADDITIONAL DATA REQUIREMENTS
52.227-21	JAN 1997	TECHNICAL DATA DECLARATION, REVISION, AND WITHHOLDING OF PAYMENT-MAJOR SYSTEMS (Offeror to fill in (if appropriate) (b)(1).)
52.228-5	JAN 1997	INSURANCE-WORK ON A GOVERNMENT INSTALLATION ( <i>Applicable only to fixed price</i> )
52.228-7	MAR 1996	INSURANCE—LIABILITY TO THIRD PERSONS ( <i>Applicable only to cost reimbursable</i> )
52.229-1	APR 1984	STATE AND LOCAL TAXES ( <i>Applicable only to fixed price</i> )
52.229-3	APR 2003	FEDERAL, STATE, AND LOCAL TAXES ( <i>Applicable only to fixed price</i> )
52.230-2	APR 1998	COST ACCOUNTING STANDARDS
52.230-6	NOV 1999	ADMINISTRATION OF COST ACCOUNTING STANDARDS
52.232-2	APR 1984	PAYMENTS UNDER FIXED-PRICE RESEARCH AND DEVELOPMENT CONTRACTS ( <i>Applicable only to fixed price</i> )
52.232-17	JUN 1996	INTEREST
52.232-22	APR 1984	LIMITATION OF FUNDS ( <i>Applicable only to cost reimbursable</i> )
52.232-23	JAN 1986	ASSIGNMENT OF CLAIMS
52.232-25	OCT 2003	PROMPT PAYMENT

52.232-34	MAY 1999	PAYMENT BY ELECTRONIC FUNDS TRANSFER--OTHER THAN CENTRAL CONTRACTOR REGISTRATION (Insert in paragraph (b)(1) "no later than concurrent with the first request for payment".)
52.233-1	JULY 2002	DISPUTES (ALT I) (DEC 1991)
52.233-3	AUG 1996	PROTEST AFTER AWARD (ALT I) (JUN 1985) ( <i>Applicable only to cost reimbursable</i> )
52.233-4	OCT 2004	APPLICABLE LAW FOR BREACH OF CONTRACT CLAIM
52.237-2	APR 1984	PROTECTION OF GOVERNMENT BUILDINGS, EQUIPMENT, AND VEGETATION
52.242-1	APR 1984	NOTICE OF INTENT TO DISALLOW COSTS
52.242-3	MAY 2001	PENALTIES FOR UNALLOWABLE COSTS
52.242-4	JAN 1997	CERTIFICATION OF FINAL INDIRECT COSTS
52.242-13	JUL 1995	BANKRUPTCY
52.243-2	AUG 1987	CHANGES--COST-REIMBURSEMENT (ALT V) (APR 1984)
52.243-6	APR 1984	CHANGE ORDER ACCOUNTING
52.243-7	APR 1984	NOTIFICATION OF CHANGES
52.244-2	AUG 1998	SUBCONTRACTS (ALT I) (MAR 2005) (Insert "All foreign subcontracts, other subcontracts greater than \$50 Million, and any subcontracts with Limited Data Rights " in paragraph (e) and "none" in paragraph (k)) ( <i>Applicable only to cost reimbursable</i> )
52.244-5	DEC 1996	COMPETITION IN SUBCONTRACTING
52.244-6	DEC 2004	SUBCONTRACTS FOR COMMERCIAL ITEMS
52.245-1	APR 1984	PROPERTY RECORDS
52.245-2	MAY 2004	GOVERNMENT PROPERTY (FIXED PRICE CONTRACTS) ( <i>Applicable only to fixed price</i> )
52.245-5	MAY 2004	GOVERNMENT PROPERTY (COST-REIMBURSEMENT, TIME-AND-MATERIAL, OR LABOR-HOUR CONTRACTS) (DEVIATION) (AS MODIFIED BY NASA PIC 04-12) ) (See attachment J-11) ( <i>Applicable only to cost reimbursable</i> )
52.245-9	AUG 2005	USE AND CHARGES ( <i>Applicable only to fixed price</i> )
52.245-17	MAY 2004	SPECIAL TOOLING



52.245-18	FEB 1993	SPECIAL TEST EQUIPMENT
52.246-24	FEB 1997	LIMITATION OF LIABILITY – HIGH VALUE ITEMS, (ALT I) (APR 1984)
52.247-1	APR 1984	COMMERCIAL BILL OF LADING NOTATIONS
52.247-63	JUN 2003	PREFERENCE FOR U.S.-FLAG AIR CARRIERS
52.248-1	FEB 2000	VALUE ENGINEERING
52.249-2	MAY 2004	TERMINATION FOR CONVENIENCE OF THE GOVERNMENT (FIXED-PRICE) <i>(Applicable only to fixed price)</i>
52.249-6	MAY 2004	TERMINATION (COST-REIMBURSEMENT) <i>(Applicable only to cost reimbursable)</i>
52.249-9	APR 1984	DEFAULT (FIXED-PRICES) <i>(Applicable only to fixed price)</i>
52.249-14	APR 1984	EXCUSABLE DELAYS
52.251-1	APR 1984	GOVERNMENT SUPPLY SOURCES
52.251-2	JAN 1991	INTERAGENCY FLEET MANAGEMENT SYSTEMS VEHICLES AND RELATED SERVICES <i>(Applicable only to cost reimbursable)</i>
52.253-1	JAN 1991	COMPUTER GENERATED FORMS

## II. NASA FAR SUPPLEMENT (48 CFR CHAPTER 18) PROVISIONS

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
1852.203-70	JUN 2001	DISPLAY OF INSPECTOR GENERAL HOTLINE POSTERS
1852.216-89	JUL 1997	ASSIGNMENT AND RELEASE FORMS <i>(Applicable only to cost reimbursable)</i>
1852.219-74	SEPT 1990	USE OF RURAL AREA SMALL BUSINESSES
1852.219-75	MAY 1999	SMALL BUSINESS SUBCONTRACTING REPORTING
1852.219-76	JUL 1997	NASA 8 PERCENT GOAL
1852.223-74	MAR 1996	DRUG-AND ALCOHOL-FREE WORKFORCE
1852.227-86	DEC 1987	COMMERCIAL COMPUTER SOFTWARE--LICENSING
1852.227-87	APR 1989	TRANSFER OF TECHNICAL DATA UNDER SPACE STATION INTERNATIONAL AGREEMENTS
1852.228-75	OCT 1988	MINIMUM INSURANCE COVERAGE
1852.235-70	FEB 2003	CENTER FOR AEROSPACE INFORMATION
1852.237-70	DEC 1988	EMERGENCY EVACUATION PROCEDURES
1852.237-72	JUN 2005	ACCESS TO SENSITIVE INFORMATION

1852.237-73	JUN 2005	RELEASE OF SENSITIVE INFORMATION
1852.242-78	APR 2001	EMERGENCY MEDICAL SERVICES AND EVACUATION
1852.243-71	MAR 1997	SHARED SAVINGS

(End of By Reference Section)

**I.2 APPROVAL OF CONTRACT (FAR 52.204-1) (DEC 1989)**

This contract is subject to the written approval of the JSC Procurement Officer and shall not be binding until so approved.

(End of clause)

**I.3 RESERVED**

(End of clause)

**I.4 SECURITY REQUIREMENTS FOR UNCLASSIFIED INFORMATION TECHNOLOGY RESOURCES (NASA 1852.204-76) (NOV 2004)**

a) The Contractor shall be responsible for Information Technology security for all systems connected to a NASA network or operated by the Contractor for NASA, regardless of location. This clause is applicable to all or any part of the contract that includes information technology resources or services in which the Contractor must have physical or electronic access to NASA's sensitive information contained in unclassified systems that directly support the mission of the Agency. This includes information technology, hardware, software, and the management, operation, maintenance, programming, and system administration of computer systems, networks, and telecommunications systems. Examples of tasks that require security provisions include:

- (1) Computer control of spacecraft, satellites, or aircraft or their payloads;
- (2) Acquisition, transmission or analysis of data owned by NASA with significant replacement cost should the contractor's copy be corrupted; and
- (3) Access to NASA networks or computers at a level beyond that granted the general public, e.g. bypassing a firewall.

b) The Contractor shall provide, implement, and maintain an IT Security Plan. This plan shall describe the processes and procedures that will be followed to ensure appropriate security of IT resources that are developed, processed, or used under this contract. The plan shall describe those parts of the contract to which this clause applies. The Contractor's IT Security Plan shall be compliant with Federal laws that include, but are not limited to, the Computer Security Act of 1987 (40 U.S.C. 1441 et seq.) and the Government Information Security Reform Act of 2000. The plan shall meet IT security requirements in accordance with Federal and NASA policies and procedures that include, but are not limited to:

- (1) OMB Circular A-130, Management of Federal Information Resources, Appendix III, Security of Federal Automated Information Resources;
- (2) NASA Procedures and Guidelines (NPR) 2810.1, Security of Information Technology; and
- (3) Chapter 3 of NPR 1620.1, NASA Security Procedural Requirements.

- c) Within 45 calendar days after contract award, the contractor shall submit for NASA approval an IT Security Plan. This plan must be consistent with and further detail the approach contained in the offeror's proposal or sealed bid that resulted in the award of this contract and in compliance with the requirements stated in this clause. The plan, as approved by the Contracting Officer, shall be incorporated into the contract as a compliance document.
- d)(1) Contractor personnel requiring privileged access or limited privileged access to systems operated by the Contractor for NASA or interconnected to a NASA network shall be screened at an appropriate level in accordance with NPR 2810.1, Section 4.5; NPR 1620.1, Chapter 3; and paragraph (d)(2) of this clause. Those Contractor personnel with non-privileged access do not require personnel screening. NASA shall provide screening using standard personnel screening National Agency Check (NAC) forms listed in paragraph (d)(3) of this clause, unless contractor screening in accordance with paragraph (d)(4) is approved. The Contractor shall submit the required forms to the NASA Center Chief of Security (CCS) within fourteen (14) days after contract award or assignment of an individual to a position requiring screening. The forms may be obtained from the CCS. At the option of the government, interim access may be granted pending completion of the NAC.
- (2) Guidance for selecting the appropriate level of screening is based on the risk of adverse impact to NASA missions. NASA defines three levels of risk for which screening is required (IT-1 has the highest level of risk):
- (i) **IT-1** -- Individuals having privileged access or limited privileged access to systems whose misuse can cause very serious adverse impact to NASA missions. These systems include, for example, those that can transmit commands directly modifying the behavior of spacecraft, satellites or aircraft.
  - (ii) **IT-2** -- Individuals having privileged access or limited privileged access to systems whose misuse can cause serious adverse impact to NASA missions. These systems include, for example, those that can transmit commands directly modifying the behavior of payloads on spacecraft, satellites or aircraft; and those that contain the primary copy of "level 1" data whose cost to replace exceeds one million dollars.
  - (iii) **IT-3** -- Individuals having privileged access or limited privileged access to systems whose misuse can cause significant adverse impact to NASA missions. These systems include, for example, those that interconnect with a NASA network in a way that exceeds access by the general public, such as bypassing firewalls; and systems operated by the contractor for NASA whose function or data has substantial cost to replace, even if these systems are not interconnected with a NASA network.
- (3) Screening for individuals shall employ forms appropriate for the level of risk as follows:
- (i) IT-1: Fingerprint Card (FC) 258 and Standard Form (SF) 85P, Questionnaire for Public Trust Positions;
  - (ii) IT-2: FC 258 and SF 85, Questionnaire for Non-Sensitive Positions; and
  - (iii) IT-3: NASA Form 531, Name Check, and FC 258.
- (4) The Contracting Officer may allow the Contractor to conduct its own screening of individuals requiring privileged access or limited privileged access provided the Contractor can demonstrate

that the procedures used by the Contractor are equivalent to NASA's personnel screening procedures. As used here, equivalent includes a check for criminal history, as would be conducted by NASA, and completion of a questionnaire covering the same information as would be required by NASA.

- (5) Screening of contractor personnel may be waived by the Contracting Officer for those individuals who have proof of –
- (i) Current or recent national security clearances (within last three years);
  - (ii) Screening conducted by NASA within last three years; or
  - (iii) Screening conducted by the Contractor, within last three years, that is equivalent to the NASA personnel screening procedures as approved by the Contracting Officer under paragraph (d)(4) of this clause.
- e) The Contractor shall ensure that its employees, in performance of the contract, receive annual IT security training in NASA IT Security policies, procedures, computer ethics, and best practices in accordance with NPR 2810.1, Section 4.3 requirements. The contractor may use web-based training available from NASA to meet this requirement.
- f) The Contractor shall afford NASA, including the Office of Inspector General, access to the Contractor's and subcontractors' facilities, installations, operations, documentation, databases and personnel used in performance of the contract. Access shall be provided to the extent required to carry out a program of IT inspection, investigation and audit to safeguard against threats and hazards to the integrity, availability and confidentiality of NASA data or to the function of computer systems operated on behalf of NASA, and to preserve evidence of computer crime.
- g) The Contractor shall incorporate the substance of this clause in all subcontracts that meet the conditions in paragraph (a) of this clause.

(End of clause)

**I.5 OMBUDSMAN (NASA 1852.215-84) (OCT 2003) (ALT I) (JUN 2000)**

- (a) An ombudsman has been appointed to hear and facilitate the resolution of concerns from offerors, potential offerors, and contractors during the preaward and postaward phases of this acquisition. When requested, the ombudsman will maintain strict confidentiality as to the source of the concern. The existence of the ombudsman is not to diminish the authority of the contracting officer, the Source Evaluation Board, or the selection official. Further, the ombudsman does not participate in the evaluation of proposals, the source selection process, or the adjudication of formal contract disputes. Therefore, before consulting with an ombudsman, interested parties must first address their concerns, issues, disagreements, and/or recommendations to the contracting officer for resolution.
- (b) If resolution cannot be made by the contracting officer, interested parties may contact the installation ombudsman, Randy K. Gish, Attn: Mail Code AC, 2101 NASA Parkway, Houston, TX 77058, 281-483-0490, facsimile 281-483-2200, email: randy.k.gish@nasa.gov.

- (c) If this is a task or delivery order contract, the ombudsman shall review complaints from contractors and ensure they are afforded a fair opportunity to be considered, consistent with the procedures of the contract.

(End of clause)

**I.6 ORDERING (52.216-18) (OCT 1995)**

- (a) Any supplies and services to be furnished under this contract shall be ordered by issuance of delivery orders or task orders by the individuals or activities designated in the Schedule. Such orders may be issued from *September 8, 2009 through September 7, 2014*.
- (b) All delivery orders or task orders are subject to the terms and conditions of this contract. In the event of conflict between a delivery order or task order and this contract, the contract shall control.
- (c) If mailed, a delivery order or task order is considered "issued" when the Government deposits the order in the mail. Orders may be issued orally, by facsimile, or by electronic commerce methods only if authorized in the Schedule.

(End of clause)

**I.7 ORDER LIMITATIONS (52.216-19) (OCT 1995)**

- (a) Minimum order. When the Government requires supplies or services covered by this contract in an amount of less than 1 vehicle the Government is not obligated to purchase, nor is the Contractor obligated to furnish, those supplies or services under the contract.
- (b) Maximum order. The Contractor is not obligated to honor-
- (1) Any order for a single item in excess of 6 per year.
  - (2) Any order for a combination of items in excess of 6 per year; or
  - (3) A series of orders from the same ordering office within 5 business days that together call for quantities exceeding the limitation in paragraph (b)(1) or (2) of this section.
- (c) If this is a requirements contract (i.e., includes the Requirements clause at subsection 52.216-21 of the Federal Acquisition Regulation (FAR)), the Government is not required to order a part of any one requirement from the Contractor if that requirement exceeds the maximum-order limitations in paragraph (b) of this section.
- (d) Notwithstanding paragraphs (b) and (c) of this section, the Contractor shall honor any order exceeding the maximum order limitations in paragraph (b), unless that order (or orders) is returned to the ordering office within 5 business days after issuance, with written notice stating the Contractor's intent not to ship the item (or items) called for and the reasons. Upon receiving this notice, the Government may acquire the supplies or services from another source.

(End of clause)

**I.8 INDEFINITE QUANTITY (52.216-22) (OCT 1995)**

- (a) This is an indefinite-quantity contract for the supplies or services specified, and effective for the period stated, in the Schedule. The quantities of supplies and services specified in the Schedule are estimates only and are not purchased by this contract.
- (b) Delivery or performance shall be made only as authorized by orders issued in accordance with the Ordering clause. The Contractor shall furnish to the Government, when and if ordered, the supplies or services specified in the Schedule up to and including the quantity designated in the Schedule as the "maximum." The Government shall order at least the quantity of supplies or services designated in the Schedule as the "minimum."
- (c) Except for any limitations on quantities in the Order Limitations clause or in the Schedule, there is no limit on the number of orders that may be issued. The Government may issue orders requiring delivery to multiple destinations or performance at multiple locations.
- (d) Any order issued during the effective period of this contract and not completed within that period shall be completed by the Contractor within the time specified in the order. The contract shall govern the Contractor's and Government's rights and obligations with respect to that order to the same extent as if the order were completed during the contract's effective period; provided, that the Contractor shall not be required to make any deliveries beyond 12 months after contract period of performance identified in ordering period identified in I.6 "Ordering".

(End of clause)

**I.9 PAYMENT FOR OVERTIME PREMIUMS (FAR 52.222-2) (JUL 1990) (Applicable only to cost reimbursable)**

- (a) The use of overtime is authorized under this contract if the overtime premium does not exceed \$0 or the overtime premium is paid for work-
  - (1) Necessary to cope with emergencies such as those resulting from accidents, natural disasters, breakdowns of production equipment, or occasional production bottlenecks of a sporadic nature;
  - (2) By indirect-labor employees such as those performing duties in connection with administration, protection, transportation, maintenance, standby plant protection, operation of utilities, or accounting;
  - (3) To perform tests, industrial processes, laboratory procedures, loading or unloading of transportation conveyances, and operations in flight or afloat that are continuous in nature and cannot reasonably be interrupted or completed otherwise; or
  - (4) That will result in lower overall costs to the Government.
- (b) Any request for estimated overtime premiums that exceeds the amount specified above shall include all estimated overtime for contract completion and shall-

- (1) Identify the work unit; e.g., department or section in which the requested overtime will be used, together with present workload, staffing, and other data of the affected unit sufficient to permit the Contracting Officer to evaluate the necessity for the overtime;
- (2) Demonstrate the effect that denial of the request will have on the contract delivery or performance schedule;
- (3) Identify the extent to which approval of overtime would affect the performance or payments in connection with other Government contracts, together with identification of each affected contract; and
- (4) Provide reasons why the required work cannot be performed by using multishift operations or by employing additional personnel.

(End of clause)

**I.10 RIGHTS IN DATA-GENERAL (FAR 52.227-14) (JUN 1987) as modified by NASA FAR Supplement 1852.227-14, includes 52.227-14 ALT II (JUN 1987) (insertion of (g)(2), ALT III (JUN 1987) (insertion of (g)(3)(i), and ALT V (JUN 1987) (insertion of (i).**

**(a) Definitions.**

"Computer software," as used in this clause, means computer programs, computer data bases, and documentation thereof.

"Data," as used in this clause, means recorded information, regardless of form or the media on which it may be recorded. The term includes technical data and computer software. The term does not include information incidental to contract administration, such as financial, administrative, cost or pricing, or management information.

"Form, fit, and function data," as used in this clause, means data relating to items, components, or processes that are sufficient to enable physical and functional interchangeability, as well as data identifying source, size, configuration, mating, and attachment characteristics, functional characteristics, and performance requirements; except that for computer software it means data identifying source, functional characteristics, and performance requirements but specifically excludes the source code, algorithm, process, formulae, and flow charts of the software.

"Limited rights," as used in this clause, means the rights of the Government in limited rights data as set forth in the Limited Rights Notice of paragraph (g)(2) if included in this clause.

"Limited rights data," as used in this clause, means data (other than computer software) that embody trade secrets or are commercial or financial and confidential or privileged, to the extent that such data pertain to items, components, or processes developed at private expense, including minor modifications thereof.

"Restricted computer software," as used in this clause, means computer software developed at private expense and that is a trade secret; is commercial or financial and is confidential or privileged; or is published copyrighted computer software, including minor modifications of such computer software.

"Restricted rights," as used in this clause, means the rights of the Government in restricted computer software, as set forth in a Restricted Rights Notice of paragraph (g)(3) if included in this clause, or as otherwise may be provided in a collateral agreement incorporated in and made part of this contract, including minor modifications of such computer software.

"Technical data," as used in this clause, means data (other than computer software) which are of a scientific or technical nature.

"Unlimited rights," as used in this clause, means the right of the Government to use, disclose, reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, in any manner and for any purpose, and to have or permit others to do so.

*(b) Allocation of rights.*

(1) Except as provided in paragraph (c) of this clause regarding copyright, the Government shall have unlimited rights in-

(i) Data first produced in the performance of this contract;

(ii) Form, fit, and function data delivered under this contract;

(iii) Data delivered under this contract (except for restricted computer software) that constitute manuals or instructional and training material for installation, operation, or routine maintenance and repair of items, components, or processes delivered or furnished for use under this contract; and

(iv) All other data delivered under this contract unless provided otherwise for limited rights data or restricted computer software in accordance with paragraph (g) of this clause.

(2) The Contractor shall have the right to-

(i) Use, release to others, reproduce, distribute, or publish any data first produced or specifically used by the Contractor in the performance of this contract, unless provided otherwise in paragraph (d) of this clause;

(ii) Protect from unauthorized disclosure and use those data which are limited rights data or restricted computer software to the extent provided in paragraph (g) of this clause;

(iii) Substantiate use of, add or correct limited rights, restricted rights, or copyright notices and to take other appropriate action, in accordance with paragraphs (e) and (f) of this clause; and

(iv) Establish claim to copyright subsisting in data first produced in the performance of this contract to the extent provided in paragraph (c)(1) of this clause.

*(c) Copyright-*



- (1) Data first produced in the performance of this contract. Unless provided otherwise in paragraph (d) of this clause, the Contractor may establish, without prior approval of the Contracting Officer, claim to copyright subsisting in scientific and technical articles based on or containing data first produced in the performance of this contract and published in academic, technical or professional journals, symposia proceedings or similar works. The prior, express written permission of the Contracting Officer is required to establish claim to copyright subsisting in all other data first produced in the performance of this contract. When claim to copyright is made, the Contractor shall affix the applicable copyright notices of 17 U.S.C. 401 or 402 and acknowledgment of Government sponsorship (including contract number) to the data when such data are delivered to the Government, as well as when the data are published or deposited for registration as a published work in the U.S. Copyright Office. For data other than computer software the Contractor grants to the Government, and others acting on its behalf, a paid-up, nonexclusive, irrevocable worldwide license in such copyrighted data to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the Government. For computer software, the Contractor grants to the Government and others acting in its behalf, a paid-up nonexclusive, irrevocable worldwide license in such copyrighted computer software to reproduce, prepare derivative works, and perform publicly and display publicly by or on behalf of the Government.
  - (2) Data not first produced in the performance of this contract. The Contractor shall not, without prior written permission of the Contracting Officer, incorporate in data delivered under this contract any data not first produced in the performance of this contract and which contains the copyright notice of 17 U.S.C. 401 or 402, unless the Contractor identifies such data and grants to the Government, or acquires on its behalf, a license of the same scope as set forth in paragraph (c)(1) of this clause; provided, however, that if such data are computer software the Government shall acquire a copyright license as set forth in paragraph (g)(3) of this clause if included in this contract or as otherwise may be provided in a collateral agreement incorporated in or made part of this contract.
  - (3) Removal of copyright notices. The Government agrees not to remove any copyright notices placed on data pursuant to this paragraph (c), and to include such notices on all reproductions of the data.
- (d) Release, publication and use of data
- (1) The Contractor shall have the right to use, release to others, reproduce, distribute, or publish any data first produced or specifically used by the Contractor in the performance of this contract, except to the extent such data may be subject to the Federal export control or national security laws or regulations, or unless otherwise provided in this paragraph of this clause or expressly set forth in this contract.
  - (2) The Contractor agrees that to the extent it receives or is given access to data necessary for the performance of this contract which contain restrictive markings, the Contractor shall treat the data in accordance with such markings unless otherwise specifically authorized in writing by the Contracting Officer.

(e) Unauthorized marking of data.

- (1) Notwithstanding any other provisions of this contract concerning inspection or acceptance, if any data delivered under this contract are marked with the notices specified in paragraph (g)(2) or (g)(3) of this clause and use of such is not authorized by this clause, or if such data bears any other restrictive or limiting markings not authorized by this contract, the Contracting Officer may at any time either return the data to the Contractor, or cancel or ignore the markings. However, the following procedures shall apply prior to canceling or ignoring the markings.
  - (i) The Contracting Officer shall make written inquiry to the Contractor affording the Contractor 30 days from receipt of the inquiry to provide written justification to substantiate the propriety of the markings;
  - (ii) If the Contractor fails to respond or fails to provide written justification to substantiate the propriety of the markings within the 30-day period (or a longer time not exceeding 90 days approved in writing by the Contracting Officer for good cause shown), the Government shall have the right to cancel or ignore the markings at any time after said period and the data will no longer be made subject to any disclosure prohibitions.
  - (iii) If the Contractor provides written justification to substantiate the propriety of the markings within the period set in subdivision (e)(1)(i) of this clause, the Contracting Officer shall consider such written justification and determine whether or not the markings are to be cancelled or ignored. If the Contracting Officer determines that the markings are authorized, the Contractor shall be so notified in writing. If the Contracting Officer determines, with concurrence of the head of the contracting activity, that the markings are not authorized, the Contracting Officer shall furnish the Contractor a written determination, which determination shall become the final agency decision regarding the appropriateness of the markings unless the Contractor files suit in a court of competent jurisdiction within 90 days of receipt of the Contracting Officer's decision. The Government shall continue to abide by the markings under this subdivision (e)(1)(iii) until final resolution of the matter either by the Contracting Officer's determination becoming final (in which instance the Government shall thereafter have the right to cancel or ignore the markings at any time and the data will no longer be made subject to any disclosure prohibitions), or by final disposition of the matter by court decision if suit is filed.
- (2) The time limits in the procedures set forth in paragraph (e)(1) of this clause may be modified in accordance with agency regulations implementing the Freedom of Information Act (5 U.S.C. 552) if necessary to respond to a request thereunder.
- (3) This paragraph (e) does not apply if this contract is for a major system or for support of a major system by a civilian agency other than NASA and the U.S. Coast Guard agency subject to the provisions of Title III of the Federal Property and Administrative Services Act of 1949.
- (4) Except to the extent the Government's action occurs as the result of final disposition of the matter by a court of competent jurisdiction, the Contractor is not precluded by this paragraph (e) from bringing a claim under the Contract Disputes Act, including pursuant to the Disputes clause of

this contract, as applicable, that may arise as the result of the Government removing or ignoring authorized markings on data delivered under this contract.

(f) Omitted or incorrect markings.

(1) Data delivered to the Government without either the limited rights or restricted rights notice as authorized by paragraph (g) of this clause, or the copyright notice required by paragraph (c) of this clause, shall be deemed to have been furnished with unlimited rights, and the Government assumes no liability for the disclosure, use, or reproduction of such data. However, to the extent the data has not been disclosed without restriction outside the Government, the Contractor may request, within 6 months (or a longer time approved by the Contracting Officer for good cause shown) after delivery of such data, permission to have notices placed on qualifying data at the Contractor's expense, and the Contracting Officer may agree to do so if the Contractor-

(i) Identifies the data to which the omitted notice is to be applied;

(ii) Demonstrates that the omission of the notice was inadvertent;

(iii) Establishes that the use of the proposed notice is authorized; and

(iv) Acknowledges that the Government has no liability with respect to the disclosure, use, or reproduction of any such data made prior to the addition of the notice or resulting from the omission of the notice.

(2) The Contracting Officer may also (i) permit correction at the Contractor's expense of incorrect notices if the Contractor identifies the data on which correction of the notice is to be made, and demonstrates that the correct notice is authorized, or (ii) correct any incorrect notices.

(g) Protection of limited rights data and restricted computer software.

(1) When data other than that listed in subdivisions (b)(1)(i), (ii), and (iii) of this clause are specified to be delivered under this contract and qualify as either limited rights data or restricted computer software, if the Contractor desires to continue protection of such data, the Contractor shall withhold such data and not furnish them to the Government under this contract. As a condition to this withholding, the Contractor shall identify the data being withheld and furnish form, fit, and function data in lieu thereof. Limited rights data that are formatted as a computer data base for delivery to the Government are to be treated as limited rights data and not restricted computer software.

(2) Notwithstanding paragraph (g)(1) of this clause, the contract may identify and specify the delivery of limited rights data, or the Contracting Officer may require by written request the delivery of limited rights data that has been withheld or would otherwise be withholdable. If delivery of such data is so required, the Contractor may affix the following "Limited Rights Notice" to the data and the Government will thereafter treat the data, subject to the provisions of paragraphs (e) and (f) of this clause, in accordance with such Notice:

**Limited Rights Notice (June 1987)**

- (a) These data are submitted with limited rights under Government Contract No. (and subcontract, if appropriate). These data may be reproduced and used by the Government with the express limitation that they will not, without written permission of the Contractor, be used for purposes of manufacture nor disclosed outside the Government; except that the Government may disclose these data outside the Government for the following purposes, if any; provided that the Government makes such disclosure subject to prohibition against further use and disclosure:
- (1) Use (except for manufacture) by support service Contractors.
  - (2) Evaluation by nongovernment evaluators.
  - (3) Use (except for manufacture) by other Contractors participating in the Government's program of which the specific contract is a part, for information and use in connection with the work performed under each contract.
  - (4) Emergency repair or overhaul work.
  - (5) Release to a foreign government, or instrumentality thereof, as the interests of the United States Government may require, for information or evaluation, or for emergency repair or overhaul work by such government.
- (b) This Notice shall be marked on any reproduction of these data, in whole or in part.

**(End of notice)**

- (3) (i) Notwithstanding paragraph (g)(1) of this clause, the contract may identify and specify the delivery of restricted computer software, or the Contracting Officer may require by written request the delivery of restricted computer software that has been withheld or would otherwise be withholdable. If delivery of such computer software is so required, the Contractor may affix the following "Restricted Rights Notice" to the computer software and the Government will thereafter treat the computer software, subject to paragraphs (e) and (f) of this clause, in accordance with the Notice:

**Restricted Rights Notice (June 1987)**

- (a) This computer software is submitted with restricted rights under Government Contract No. \_\_\_\_\_ (and subcontract, if appropriate). It may not be used, reproduced, or disclosed by the Government except as provided in paragraph (b) of this Notice or as otherwise expressly stated in the contract.
- (b) This computer software may be-
- (1) Used or copied for use in or with the computer or computers for which it was acquired, including use at any Government installation to which such computer or computers may be transferred;

- (2) Used or copied for use in a backup computer if any computer for which it was acquired is inoperative;
  - (3) Reproduced for safekeeping (archives) or backup purposes;
  - (4) Modified, adapted, or combined with other computer software, provided that the modified, combined, or adapted portions of the derivative software incorporating restricted computer software are made subject to the same restricted rights;
  - (5) Disclosed to and reproduced for use by support service Contractors in accordance with paragraphs (b)(1) through (4) of this clause, provided the Government makes such disclosure or reproduction subject to these restricted rights; and
  - (6) Used or copied for use in or transferred to a replacement computer.
- (c) Notwithstanding the foregoing, if this computer software is published copyrighted computer software, it is licensed to the Government, without disclosure prohibitions, with the minimum rights set forth in paragraph (b) of this clause.
- (d) Any other rights or limitations regarding the use, duplication, or disclosure of this computer software are to be expressly stated in, or incorporated in, the contract.
- (e) This Notice shall be marked on any reproduction of this computer software, in whole or in part.

**(End of notice)**

- (ii) Where it is impractical to include the Restricted Rights Notice on restricted computer software, the following short-form Notice may be used in lieu thereof:

**Restricted Rights Notice Short Form (June 1987)**

Use, reproduction, or disclosure is subject to restrictions set forth in Contract No. (and subcontract, if appropriate) with (name of Contractor and subcontractor).

**(End of notice)**

- (iii) If restricted computer software is delivered with the copyright notice of 17 U.S.C. 401, it will be presumed to be published copyrighted computer software licensed to the Government without disclosure prohibitions, with the minimum rights set forth in paragraph (b) of this clause, unless the Contractor includes the following statement with such copyright notice: "Unpublished-rights reserved under the Copyright Laws of the United States."

- (h) Subcontracting. The Contractor has the responsibility to obtain from its subcontractors all data and rights therein necessary to fulfill the Contractor's obligations to the Government under this contract. If a subcontractor refuses to accept terms affording the Government such rights, the Contractor shall

promptly bring such refusal to the attention of the Contracting Officer and not proceed with subcontract award without further authorization.

- (i) Relationship to patents. Nothing contained in this clause shall imply a license to the Government under any patent or be construed as affecting the scope of any license or other right otherwise granted to the Government.
- (j) The Contractor agrees, except as may be otherwise specified in this contract for specific data items listed as not subject to this paragraph, that the Contracting Officer or an authorized representative may, up to three years after acceptance of all items to be delivered under this contract, inspect at the Contractor's facility any data withheld pursuant to paragraph (g)(1) of this clause, for purposes of verifying the Contractor's assertion pertaining to the limited rights or restricted rights status of the data or for evaluating work performance. Where the Contractor whose data are to be inspected demonstrates to the Contracting Officer that there would be a possible conflict of interest if the inspection were made by a particular representative, the Contracting Officer shall designate an alternate inspector.

(End of clause)

**I.11 RIGHTS TO PROPOSAL DATA (TECHNICAL) (FAR 52.227-23) (JUN 1987)**

Except for data contained in Volumes I through VII, including any Addendums, Amendments or Revisions thereto that are marked with the legend "LOCKHEED MARTIN PROPRIETARY INFORMATION", it is agreed that as a condition of award of this contract, and notwithstanding the conditions of any notice appearing thereon, the Government shall have unlimited rights (as defined in the "Rights in Data-General" clause contained in this contract) in and to the technical data contained in the proposals dated 20 March 2006, 20 April 2006, 21 July 2006 and 28 July 2006 upon which this contract is based.

(End of clause)

**I.12 EARNED VALUE MANAGEMENT SYSTEM (MARCH 1999) (Deviation)**

(a) In the performance of this contract, the Contractor shall use an earned value management system (EVMS) that has been recognized by the cognizant Administrative Contracting Officer (ACO) as complying with the guidelines specified in ANSI/EIA Standard 748, Industry Guidelines for Earned Value Management Systems.

(b) If, at the time of award, the Contractor's EVMS has not been recognized by the ACO as complying with the EVMS guidelines, the Contractor shall apply the system to the contract and shall take timely action to implement its plan to obtain compliance. The Contractor shall follow and implement the approved compliance plan in a timely fashion. The Government will conduct a Compliance Review to assess the contractor's compliance with its plan, and if the Contractor does not follow the approved implementation schedule or correct all resulting system deficiencies identified as a result of the compliance review within a reasonable time, the Contracting Officer may take remedial action, that may include, but is not limited to, a reduction in fee.

(c) The Government will require integrated baseline reviews. Such reviews shall be scheduled as early as practicable and should be conducted within 180 calendar days after contract award or exercise of significant contract options; or within two months after distribution of a supplemental agreement that implemented a significant funding realignment or effected a significant change in contract requirements. The objective of IBRs is for the Government and the Contractor to jointly assess the Contractor's baseline to be used for performance measurement to ensure complete coverage of the statement of work, logical scheduling of the work activities, adequate resourcing, and identification of inherent risks.

(d) Unless a waiver is granted by the ACO, Contractor proposed EVMS changes require approval of the ACO prior to implementation. The ACO shall advise the Contractor of the acceptability of such changes within 30 calendar days after receipt of the notice of proposed changes from the Contractor. If the advance approval requirements are waived by the ACO, the Contractor shall disclose EVMS changes to the ACO and provide an information copy to the NASA Contracting Officer at least 14 calendar days prior to the effective date of implementation.

(e) The Contractor agrees to provide access to all pertinent records and data requested by the ACO or a duly authorized representative. Access is to permit Government surveillance to ensure that the EVMS complies, and continues to comply, with the criteria referenced in paragraph (a) of this clause.

(f) The Contractor shall be responsible for ensuring that the subcontractors identified below to comply with the EVMS requirements at the specified level. If the subcontractor does not have an EVMS that has been recognized by the ACO as compliant with ANSI/EIA 748, the prime contractor shall conduct Compliance Reviews of subcontractors' EVMS in the same manner as described at paragraph (b) of this clause. (Insert list of applicable subcontractors and the level of compliance (i.e., guidelines or principles).)

(g) If the contractor identifies a need to deviate from the agreed baseline by working against an Over Target Baseline or Over Target Schedule, the contractor shall submit to the Contracting Officer a request for approval to begin implementation of an Over Target Baseline or Over Target Schedule. This request shall include a top-level projection of cost and/or schedule growth, whether or not performance variances will be retained, and a schedule of implementation for the rebaselining. The Government will authorize or deny the request within 30 calendar days after receipt of the request. Failure of the Government to respond within this 30-day period constitutes approval of the request. For cost-reimbursement contracts, the contract budget baseline shall exclude changes for cost growth increases, other than for authorized changes to the contract requirements.

(End of clause)

### **I.13 ENGINEERING CHANGE PROPOSALS (NASA 1852.243-70) (OCT 2001)**

#### **(a) Definitions.**

"ECP" means an Engineering Change Proposal (ECP), which is a proposed engineering change and the documentation by which the change is described, justified, and submitted to the procuring activity for approval or disapproval.

- (b) Either party to the contract may originate ECPs. Implementation of an approved ECP may occur by either a supplemental agreement or, if appropriate, as a written change order to the contract.
- (c) Any ECP submitted to the Contracting Officer shall include a "not-to-exceed" estimated cost increase or decrease adjustment amount, if any, and the required period of performance adjustment, if any, acceptable to the originator of the ECP. If the change is originated within the Government, the Contracting Officer shall obtain a written agreement with the contractor regarding the "not-to-exceed" estimated cost and period of performance adjustments, if any, prior to issuing an order for implementation of the change.
- (d) After submission of a contractor initiated ECP, the contracting officer may require the contractor to submit the following information:
  - (1) Cost or pricing data in accordance with FAR 15.403-5 if the proposed change meets the criteria for its submission under FAR 15.403-4; or
  - (2) Information other than cost or pricing data adequate for contracting officer determination of price reasonableness or cost realism. The contracting officer reserves the right to request additional information if that provided by the contractor is considered inadequate for that purpose. If the contractor claims applicability of one of the exceptions to submission of cost or pricing data, it shall cite the exception and provide rationale for its applicability.
- (e) If the ECP is initiated by NASA, the contracting officer shall specify the cost information requirements, if any.

**ALTERNATE II (SEP 1990) *(Applicable only to cost reimbursable)***

An ECP accepted in accordance with the Changes clause of this contract shall not be considered an authorization to the contractor to exceed the estimated cost in the contract Schedule, unless the estimated cost is increased by the change order or other contract modification.

(End of clause)

**I.14 SUBMISSION OF COMMERCIAL TRANSPORTATION BILLS TO THE GENERAL SERVICES ADMINISTRATION FOR AUDIT (FAR 52.247-67) (JUN 1997) *(Applicable only to cost reimbursable)***

- (a)(1) In accordance with paragraph (a)(2) of this clause, the contractor shall submit to the General Services Administration (GSA) for audit, legible copies of all paid freight bills/invoices, commercial bills of lading (CBL's), passenger coupons, and other supporting documents for transportation services on which the United States will assume freight charges that were paid-
  - (i) By the contractor under a cost-reimbursement contract; and
  - (ii) By a first-tier subcontractor under a cost-reimbursement subcontract hereunder.
- (2) Cost-reimbursement contractors shall only submit for audit those CBL's with freight shipment charges exceeding \$50.00. Bills under \$50.00 shall be retained on-site by the contractor and



made available for GSA on-site audits. This exception only applies to freight shipment bills and is not intended to apply to bills and invoices for any other transportation services.

- (b) The contractor shall forward copies of paid freight bills/invoices, CBL's, passenger coupons, and supporting documents as soon as possible following the end of the month, in one package to the:

General Services Administration  
Attn: FWA  
1800 F. Street, NW  
Washington, DC 20405

The contractor shall include the paid freight bills/invoices, CBL's, passenger coupons, and supporting documents for first-tier subcontractors under a cost-reimbursement contract. If the inclusion of the paid freight bills/invoices, CBL's, passenger coupons, and supporting documents for any subcontractor in the shipment is not practicable, the documents may be forwarded to GSA in a separate package.

- (c) Any original transportation bills or other documents requested by GSA shall be forwarded promptly by the contractor to GSA. The contractor shall ensure that the name of the contracting agency is stamped or written on the face of the bill before sending it to GSA.
- (d) A statement prepared in duplicate by the contractor shall accompany each shipment of transportation documents. GSA will acknowledge receipt of the shipment by signing and returning the copy of the statement. The statement shall show-
- (1) The name and address of the contractor;
  - (2) The contract number including any alpha-numeric prefix identifying the contracting office;
  - (3) The name and address of the contracting office;
  - (4) The total number of bills submitted with the statement; and
  - (5) A listing of the respective amounts paid or, in lieu of such listing, an adding machine tape of the amounts paid showing the contractor's voucher or check numbers.

(End of clause)

**I.15 CLAUSES INCORPORATED BY REFERENCE (FAR 52.252-2) (FEB 1998)**

This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. Also, the full text of a clause may be accessed electronically at these addresses:

<http://www.arnet.gov/far/>  
<http://www.hq.nasa.gov/office/procurement/regs/nfstoc.htm>

(End of clause)

**I.16 AUTHORIZED DEVIATIONS IN CLAUSES (FAR 52.252-6) (APR 1984)**

- (a) The use in this solicitation or contract of any Federal Acquisition Regulation (48 CFR Chapter 1) clause with an authorized deviation is indicated by the addition of "(DEVIATION)" after the date of the clause.
- (b) The use in this solicitation or contract of any NASA (48 CFR Chapter 18) clause with an authorized deviation is indicated by the addition of "(DEVIATION)" after the name of the regulation.

(End of clause)

**I.17 INCENTIVE PRICE REVISION-SUCCESSIVE TARGETS (FAR 52.216-17) (OCT 1997)**  
**ALTERNATE I (APR 1984) (Applicable only to Fixed Price Incentive Fee (FPIF) Delivery Orders; to be tailored on an order by order basis)**

- (a) *General.* The supplies or services identified in the Schedule **delivery order** as FPIF are subject to price revision in accordance with this clause; provided, that in no event shall the total final price of these items exceed the ceiling price set forth in B.8 "CEV SPACECRAFT PRODUCTION". The prices of these items shown in the **delivery order** are the initial target prices, which include an initial target profit of TBD percent of the initial target cost. Any supplies or services that are to be
  - (1) Ordered separately under, or otherwise added to, this contract; and
  - (2) Subject to price revision in accordance with this clause shall be identified as such in a modification to this contract.
- (b) *Definition.* "Costs," as used in this clause, means allowable costs in accordance with Part 31 of the Federal Acquisition Regulation (FAR) in effect on the date of this contract.
- (c) Submitting data for establishing the firm fixed price or a final profit adjustment formula.
  - (1) Within TBD days after the end of the month in which the Contractor has completed \_\_\_\_\_ (see Note 1), the Contractor shall submit the following data:
    - (i) A proposed firm fixed price or total firm target price for supplies delivered and to be delivered and services performed and to be performed.
    - (ii) A detailed statement of all costs incurred in the performance of this contract through the end of the month specified above, in the format of Table 15-2, FAR 15.408 (or in any other form on which the parties may agree), with sufficient supporting data to disclose unit costs and cost trends for-
      - (A) Supplies delivered and services performed; and
      - (B) Inventories of work in process and undelivered contract supplies on hand (estimated to the extent necessary).
    - (iii) An estimate of costs of all supplies delivered and to be delivered and all services performed and to be performed under this contract, using the statement of costs incurred plus an estimate of costs to complete performance, in the format of Table 15-2, FAR 15.408 (or in any other form on which the parties may agree), together with-
      - (A) Sufficient data to support the accuracy and reliability of the estimate; and
      - (B) An explanation of the differences between this estimate and the original estimate used to establish the initial target prices.

- (2) The Contractor shall also submit, to the extent that it becomes available before negotiations establishing the total firm price are concluded-
  - (i) Supplemental statements of costs incurred after the end of the month specified in paragraph (1) of this section for-
    - (A) Supplies delivered and services performed; and
    - (B) Inventories of work in process and undelivered contract supplies on hand (estimated to the extent necessary); and
  - (ii) Any other relevant data that the Contracting Officer may reasonably require.
- (3) If the Contractor fails to submit the data required by paragraphs (c)(1) and (2) of this section within the time specified and it is later determined that the Government has overpaid the Contractor, the Contractor shall repay the excess to the Government immediately. Unless repaid within 30 days after the end of the data submittal period, the amount of the excess shall bear interest, computed from the date the data were due to the date of repayment, at the rate established in accordance with the Interest clause.
- (d) *Establishing firm fixed price or final profit adjustment formula.* Upon the Contracting Officer's receipt of the data required by paragraph (c) of this section, the Contracting Officer and the Contractor shall promptly establish either a firm fixed price or a profit adjustment formula for determining final profit, as follows:
  - (1) The parties shall negotiate a total firm target cost, based upon the data submitted under paragraph (c) of this section.
  - (2) If the total firm target cost is more than the total initial target cost, the total initial target profit shall be decreased. If the total firm target cost is less than the total initial target cost, the total initial target profit shall be increased. The initial target profit shall be increased or decreased by \_\_\_\_\_ percent (see Note 2) of the difference between the total initial target cost and the total firm target cost. The resulting amount shall be the total firm target profit; *provided*, that in no event shall the total firm target profit be less than TBD percent or more than TBD percent of the total initial cost.
  - (3) If the total firm target cost plus the total firm target profit represent a reasonable price for performing that part of the contract subject to price revision under this clause, the parties may agree on a firm fixed price, which shall be evidenced by a contract modification signed by the Contractor and the Contracting Officer.
  - (4) Failure of the parties to agree to a firm fixed price shall not constitute a dispute under the Disputes clause. If agreement is not reached, or if establishment of a firm fixed price is inappropriate, the Contractor and the Contracting Officer shall establish a profit adjustment formula under which the total final price shall be established by applying to the total final negotiated cost an adjustment for profit or loss, determined as follows:
    - (i) If the total final negotiated cost is equal to the total firm target cost, the adjustment is the total firm target profit.

- (ii) If the total final negotiated cost is greater than the total firm target cost, the adjustment is the total firm target profit, less TBD percent of the amount by which the total final negotiated cost exceeds the total firm target cost.
  - (iii) If the total final negotiated cost is less than the total firm target cost, the adjustment is the total firm target profit, plus TBD percent of the amount by which the total final negotiated cost is less than the total firm target cost.
  - (iv) The total firm target cost, total firm target profit, and the profit adjustment formula for determining final profit shall be evidenced by a modification to this contract signed by the Contractor and the Contracting Officer.
- (e) *Submitting data for final price revision.* Unless a firm fixed price has been established in accordance with paragraph (d) of this section within TBD days after the end of the month in which the Contractor has delivered the last unit of supplies and completed the services specified by item number in paragraph (a) of this section, the Contractor shall submit in the format of Table 15-2, FAR 15.408 (or in any other form on which the parties agree)-
- (1) A detailed statement of all costs incurred up to the end of that month in performing all work under the items;
  - (2) An estimate of costs of further performance, if any, that may be necessary to complete performance of all work under the items;
  - (3) A list of all residual inventory and an estimate of its value; and
  - (4) Any other relevant data that the Contracting Officer may reasonably require.
- (f) *Final price revision.* Unless a firm fixed price has been agreed to in accordance with paragraph (d) of this section, the Contractor and the Contracting Officer shall, promptly after submission of the data required by paragraph (e) of this section, establish the total final price, as follows:
- (1) On the basis of the information required by paragraph (e) of this section, together with any other pertinent information, the parties shall negotiate the total final cost incurred or to be incurred for the supplies delivered (or services performed) and accepted by the Government and which are subject to price revision under this clause.
  - (2) The total final price shall be established by applying to the total final negotiated cost an adjustment for final profit or loss determined as agreed upon under paragraph (d)(4) of this section.
- (g) *Contract modification.* The total final price of the items specified in paragraph (a) of this section shall be evidenced by a modification to this contract, signed by the Contractor and the Contracting Officer. This price shall not be subject to revision, notwithstanding any changes in the cost of performing the contract, except to the extent that-
- (1) The parties may agree in writing, before the determination of total final price, to exclude specific elements of cost from this price and to a procedure for subsequent disposition of these elements; and

- (2) Adjustments or credits are explicitly permitted or required by this or any other clause in this contract.

(h) Adjustment of billing prices.

- (1) Pending execution of the contract modification (see paragraph (e) of this section), the Contractor shall submit invoices or vouchers in accordance with billing prices as provided in this paragraph. The billing prices shall be the initial target prices shown in this contract until firm target prices are established under paragraph (d) of this section. When established, the firm target prices shall be used as the billing prices.
- (2) If at any time it appears from information provided by the contractor under paragraph (i)(1) of this section that the then-current billing prices will be substantially greater than the estimated final prices, the parties shall negotiate a reduction in the billing prices. Similarly, the parties may negotiate an increase in billing prices by any or all of the difference between the target prices and the ceiling price, upon the Contractor's submission of factual data showing that the final cost under this contract will be substantially greater than the target cost.
- (3) Any adjustment of billing prices shall be reflected in a contract modification and shall not affect the determination of any price under paragraph (d) or (f) of this section. After the contract modification establishing the total final price is executed, the total amount paid or to be paid on all invoices or vouchers shall be adjusted to reflect the total final price, and any resulting additional payments, refunds, or credits shall be made promptly.

(i) *Quarterly limitation on payments statement.* This paragraph (i) shall apply until a firm fixed price or a total final price is established under paragraph (d)(3) or (f)(2).

- (1) Within 45 days after the end of each quarter of the Contractor's fiscal year in which a delivery is first made (or services are first performed) and accepted by the Government under this contract, and for each quarter thereafter, the Contractor shall submit to the contract administration office (with a copy to the contracting office and the cognizant contract auditor) a statement, cumulative from the beginning of the contract, showing-
  - (i) The total contract price of all supplies delivered (or services performed) and accepted by the Government and for which final prices have been established;
  - (ii) The total cost (estimated to the extent necessary) reasonably incurred for, and properly allocable solely to, the supplies delivered (or services performed) and accepted by the Government and for which final prices have not been established;
  - (iii) The portion of the total interim profit (used in establishing the initial contract price or agreed to for the purpose of this paragraph (i)) that is in direct proportion to the supplies delivered (or services performed) and accepted by the Government and for which final prices have not been established-increased or decreased in accordance with paragraph (d)(4) of this section when the amount stated under subdivision (ii) of this section, differs from the aggregate firm target costs of the supplies or services; and
  - (iv) The total amount of all invoices or vouchers for supplies delivered (or services performed) and accepted by the Government (including amounts applied or to be applied to liquidate progress payments).

- (2) Notwithstanding any provision of this contract authorizing greater payments, if on any quarterly statement the amount under subdivision (i)(1)(iv) of this section exceeds the sum due the Contractor, as computed in accordance with subdivisions (i)(1)(i), (ii), and (iii) of this section, the Contractor shall immediately refund or credit to the Government the amount of this excess. The Contractor may, when appropriate, reduce this refund or credit by the amount of any applicable tax credits due the Contractor under 26 U.S.C. 1481 and by the amount of previous refunds or credits effected under this clause. If any portion of the excess has been applied to the liquidation of progress payments, then that portion may, instead of being refunded, be added to the unliquidated progress payment account consistent with the Progress Payments clause. The Contractor shall provide complete details to support any claimed reductions in refunds.
- (3) If the Contractor fails to submit the quarterly statement within 45 days after the end of each quarter and it is later determined that the Government has overpaid the Contractor, the Contractor shall repay the excess to the Government immediately. Unless repaid within 30 days after the end of the statement submittal period, the amount of the excess shall bear interest, computed from the date the quarterly statement was due to the date of repayment, at the rate established in accordance with the Interest clause.
- (j) *Subcontracts.* No subcontract placed under this contract may provide for payment on a cost-plus-a-percentage-of-cost basis.
- (k) *Disagreements.* If the Contractor and the Contracting Officer fail to agree upon (1) a total firm target cost and a final profit adjustment formula or (2) a total final price, within 60 days (or within such other period as the Contracting Officer may specify) after the date on which the data required in paragraphs (c) and (e) of this section are to be submitted, the Contracting Officer shall promptly issue a decision in accordance with the Disputes clause.
- (l) *Termination.* If this contract is terminated before the total final price is established, prices of supplies or services subject to price revision shall be established in accordance with this clause for (1) completed supplies and services accepted by the Government and (2) those supplies or services not terminated under a partial termination. All other elements of the termination shall be resolved in accordance with other applicable clauses of this contract.
- (m) *Equitable adjustments under other clauses.* If an equitable adjustment in the contract price is made under any other clause of this contract before the total final price is established, the adjustment shall be made in the total target cost and may be made in the maximum dollar limit on the total final price, the total target profit, or both. If the adjustment is made after the total final price is established, only the total final price shall be adjusted.
- (n) *Exclusion from target price and total final price.* If any clause of this contract provides that the contract price does not or will not include an amount for a specific purpose, then neither any target price nor the total final price includes or will include any amount for that purpose.
- (o) *Separate reimbursement.* If any clause of this contract expressly provides that the cost of performance of an obligation shall be at Government expense, that expense shall not be included in any target price or in the total final price, but shall be reimbursed separately.
- (p) *Taxes.* As used in the Federal, State, and Local Taxes clause or in any other clause that provides for certain taxes or duties to be included in, or excluded from, the contract price, the term "contract

price" includes the total target price or, if it has been established, the total final price. When any of these clauses requires that the contract price be increased or decreased as a result of changes in the obligation of the Contractor to pay or bear the burden of certain taxes or duties, the increase or decrease shall be made in the total target price or, if it has been established, in the total final price, so that it will not affect the Contractor's profit or loss on this contract.

- (q) *Provisioning and options.* Parts, other supplies, or services that are to be furnished under this contract on the basis of a provisioning document or Government option shall be subject to price revision in accordance with this clause. Any prices established for these parts, other supplies, or services under a provisioning document or Government option shall be treated as initial target prices, or target prices as agreed upon and stipulated in the pricing document supporting the provisioning or added items. Initial or firm target costs and profits and final prices covering these parts, other supplies, or services may be established separately, in the aggregate, or in any combination, as the parties may agree.

(End of clause)

(END OF SECTION)

# ATTACHMENT J-21

CREW EXPLORATION VEHICLE (CEV)

OPTION 1

SCHEDULE C



**SECTION A**  
**OMB Approval 2700-0042**

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**AWARD/CONTRACT FORM**

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(END OF SECTION)

**PART I - THE SCHEDULE**

**SECTION B - SUPPLIES OR SERVICES AND PRICE/COSTS**

**B.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

**I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

**II. NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

(End of By Reference Section)

**B.2 DESCRIPTION OF WORK**

The contractor shall, in a manner consistent with and subject to the terms and conditions hereof, furnish all resources necessary except as otherwise provided in this contract, to design, develop, test, evaluate and produce Crew Exploration Vehicle (CEV) variants that will carry human crews from Earth into space and back again. Coupled with transfer stages, landing vehicles, and surface exploration systems, the CEV will serve as an essential component of the architecture that supports human voyages to ISS, the Moon, and beyond.

This contract is divided into three separate contract schedules (A, B, and C). Terms and conditions set forth in each contract schedule apply to that schedule only.

(End of clause)

**B.3 ESTIMATED COST AND AWARD FEE (NFS 1852.216-85) (SEP 1993)**

a. The estimated cost and award fee for Schedule C (*base fee not applicable*) of this contract is broken out as follows:

	<u>Estimated Cost</u>	<u>Maximum Award Fee</u>	<u>Total Cost and Award Fee</u>
Completion form work (all work not identified as IDIQ)			
IDIQ Delivery Orders Issued**		\$0	\$0



the estimated costs for each ID/IQ Task Order. The following form is to be filled out for each of contract years.

(End of clause)  
(END OF SECTION)

## SECTION C - DESCRIPTION/SPECIFICATION/WORK STATEMENT

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### Introduction

Schedule "C", Sustaining Engineering, refers to the technical activities that improve the readiness of existing systems, improve reliability, reduce operations cost, resolve sourcing issues, reduce life cycle cost, etc. This includes, but not limited to, updating designs, introducing new materials, revising products, processes and test specifications.

Sustaining Engineering effort contained within Schedule "C" statement of work will be authorized by individual task order issued by the Contracting Officer.

### Scope

The Contractor will develop and certify all spacecraft subsystems to meet the Lunar mission requirements (Block 2) with modifications as required to support ISS mission requirements (Block 1A & 1B). The Contractor will deliver CEV spacecraft configurations below per requirements in the CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD).

The following more clearly defines the different configuration variants of the CEV Spacecraft:

1. Block 1A is a crewed, pressurized vehicle for Low Earth Orbit (LEO) (including ISS crew change out) missions. This configuration includes a habitable Crew Module (CM), and a Launch Abort System (LAS) to provide a method for crew escape and abort. A Service Module (SM) will provide propulsion and translation capability.
2. Block 1B is an uninhabited, pressurized vehicle for ISS resupply missions. It uses an uninhabited CM and an SM.



3. Block 2 is a crewed, pressurized vehicle for lunar missions. It uses a habitable CM, an LAS and an SM to support lunar missions.

Once the CEV has been accepted by NASA, the Contractor sustaining engineering team, as authorized by task order, will do sustaining engineering and operations support defined in the SOW and task order.

## **1 Project Management**

The Contractor shall maintain and comply with the Project Management processes, systems and data deliverables utilized for all contract schedules (A, B and C) throughout the life of the contract. For Schedule C, the Contractor shall perform the appropriate project management functions:

- a) The Contractor shall maintain current DRDs and data deliverables as specified in Schedule A.
- b) The Contractor shall continue management activities using the same processes established in Schedule A.
- c) The Contractor shall follow the applicable standards, documents, requirements and processes as specified in Schedule A.

## **2 Systems Engineering and Integration**

- a) The Contractor shall maintain all DRD's and products delivered in Schedules A & B in an as built configuration.
- b) The Contractor shall continue support of integration activities with Constellation Elements for Block 1 and Block 2 configurations using the same processes established in Schedule A.
- c) The Contractor shall apply all applicable documents and standards identified in Schedules A & B to the above effort.

## **3 Safety and Mission Assurance**

For existing CEV System hardware and software:

- a) The Contractor shall maintain current DRDs and data deliverables as specified in Schedule A.
- b) The Contractor shall follow the applicable standards, documents, requirements and processes as specified in Schedule A.

For new (Block 2) or modified design (from schedule A) CEV System hardware and software developed under Schedule C:

- a) The Contractor shall develop, where required (if no schedule A product exists), implement, and deliver the DRDs and data deliverables specified in Schedule A.

- b) The Contractor shall follow the applicable standards, documents, requirements and processes as specified in Schedule A.

**4      Reserved**

**5      Reserved**

**6      Spacecraft**

- a) The Contractor shall maintain all flight hardware and flight software delivered in Schedules A & B.
- b) The Contractor shall maintain all DRD's delivered in Schedules A & B in an as-built configuration.
- c) The Contractor shall develop, certify, and deliver Flight Software for Block 2 Lunar Mission Requirements (Block 2).
- d) The Contractor shall develop and certify any hardware modifications or upgrades required to maintain the Block 1 configuration and develop, certify, and deliver the Block 2 configurations.
- e) The Contractor shall maintain all facilities required to accomplish above.
- f) The Contractor shall apply all Applicable documents and standards identified in Schedules A & B to the above effort.

**7      Operations**

- a) The Contractor shall maintain all DRD's delivered in Schedules A & B in an as-built configuration.
- b) The Contractor shall provide flight and ground hardware/software technical assistance during ground operations phases to support ground operations activities, ensure operations and maintenance requirements implementation, assist in element-to-element integrated testing, assist in flight hardware/software corrective action disposition, and provide an advocate for the ground operations organizations to the spacecraft sustaining engineers.
- c) The Contractor shall provide support to the NASA flight operation's Systems, Flight Planning and Cargo Integration, Flight Design and Analysis, and Training disciplines. The Contractor shall ensure consistent, clear communications between the Contractor and NASA flight operations, gather and disseminate the necessary data and technical information from the spacecraft sustaining engineers for NASA to update and maintain its flight products, and provide an advocate for the flight operations organizations to the spacecraft sustaining engineers.
- d) The Contractor shall assess and provide recommendations regarding flight rule change requests and procedures change requests to assure that changes are consistent with CEV spacecraft requirements, constraints, and capabilities.

- e) The Contractor shall provide support during the execution of the CEV missions using the Contractor personnel supporting the NASA flight operation's Systems, Flight Planning and Cargo Integration, Flight Design and Analysis, and Training disciplines.
- f) The Contractor shall provide engineering support during the flight execution to provide technical information, interpret systems health data, and perform in-depth analysis in response to anomalous spacecraft conditions. The Contractor shall support the NASA CEV sub-system managers.
- g) For ground and flight operations, the Contractor shall provide technical support to NASA for the maintenance of training materials to reflect the as-built CEV configuration.

**8 Launch and Vehicle Services (Reserved)**

**9 Ground and Training Systems**

- a) The Contractor shall maintain all DRD's delivered in Schedules A & B in an as-built configuration.
- b) The Contractor shall support NASA in the requirements development, design, development, and implementation activities for the facilities and facility systems modifications that will be provided by NASA.
- c) The Contractor shall support NASA in the requirements development, design, development, and implementation activities resulting from new or modified NASA-provided GSE.
- d) The Contractor shall provide new or modified contractor-provided GSE to support CEV requirements.
- e) The Contractor shall support NASA ground operations sustaining engineering activities.
- f) For ground and flight operations training systems, the Contractor shall support NASA in the implementation of the new or modified training systems requirements.

**10 Flight Test (Reserved)**

(END OF SECTION)

## **SECTION D - PACKAGING AND MARKING**

### **D.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

#### **I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

#### **II. NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

(End of By Reference Section)

### **D.2 PACKAGING, HANDLING, AND TRANSPORTATION (NASA 1852.211-70) (SEP 2005)**

- (a) The Contractor shall comply with NASA Procedural Requirements (NPR) 6000.1, "Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components", as may be supplemented by the statement of work or specifications of this contract, for all items designated as Class I, II, or III.
- (b) The Contractor's packaging, handling, and transportation procedures may be used, in whole or in part, subject to the written approval of the Contracting Officer, provided (1) the Contractor's procedures are not in conflict with any requirements of this contract, and (2) the requirements of this contract shall take precedence in the event of any conflict with the Contractor's procedures.
- (c) The Contractor must place the requirements of this clause in all subcontracts for items that will become components of deliverable Class I, II, or III items.

(End of clause)

(END OF SECTION)

## **SECTION E - INSPECTION AND ACCEPTANCE**

---

### **E.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

#### **I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
52.246-5	APR 1984	INSPECTION OF SERVICES - COST REIMBURSEMENT
52.246-8	MAY 2001	INSPECTION OF RESEARCH AND DEVELOPMENT-COST-REIMBURSEMENT

#### **II. NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
1852.246-73	MAR 1997	HUMAN SPACE FLIGHT ITEM

(End of By Reference Section)

### **E.2 HIGHER-LEVEL CONTRACT QUALITY REQUIREMENT (FAR 52.246-11) (FEB 1999)**

The contractor shall comply with the higher-level quality standard selected below:

SAE AS9100, Quality Systems-Aerospace, model for Quality Assurance in Design, Development, Production, Installation and Servicing

(End of clause)

### **E.3 MATERIAL INSPECTION AND RECEIVING REPORT (NFS 1852.246-72) (AUG 2003)**

- (a) At the time of each delivery to the Government under this contract, the Contractor shall furnish a Material Inspection and Receiving Report (DD Form 250 series) prepared in six (including original) copies, an original and five copies.
- (b) The Contractor shall prepare the DD Form 250 in accordance with NASA FAR Supplement 1846.6 . The Contractor shall enclose the copies of the DD Form 250 in the package or seal them in a

waterproof envelope, which shall be securely attached to the exterior of the package in the most protected location.

- (c) When more than one package is involved in a shipment, the Contractor shall list on the DD Form 250, as additional information, the quantity of packages and the package numbers. The Contractor shall forward the DD Form 250 with the lowest numbered package of the shipment and print the words "CONTAINS DD FORM 250" on the package.

(End of clause)

**E.4 PRELIMINARY INSPECTION AT SOURCE AND FINAL INSPECTION AND  
ACCEPTANCE AT DESTINATION (JSC 52.246-91) (JUN 1991)**

Preliminary inspection for compliance with the contract specifications and requirements may be performed at origin by an authorized representative of the Government, and final inspection and acceptance will be performed by the contracting officer or his/her authorized representative at the destination.

(End of clause)

(END OF SECTION)

## SECTION F - DELIVERIES OR PERFORMANCE

### F.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

#### I. **FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
52.242-15	AUG 1989	STOP-WORK ORDER (ALT I) (APR 1984)
52.247-29	FEB 2006	F.O.B. ORIGIN

#### II. **NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

(End of By Reference Section)

### F.2 RESERVED

(End of clause)

### F.3 BILLS OF LADING (NFS 1852.247-73) (JUN 2002)

The purpose of this clause is to define when a commercial bill of lading or a government bill of lading is to be used when shipments of deliverable items under this contract are Free On Board (F.O.B.) origin.

- (a) Commercial Bills of Lading. All domestic shipments shall be made via commercial bills of lading (CBLs). The Contractor shall prepay domestic transportation charges. The Government shall reimburse the Contractor for these charges if they are added to the invoice as a separate line item supported by the paid freight receipts. If paid receipts in support of the invoice are not obtainable, a statement as described below must be completed, signed by an authorized company representative, and attached to the invoice. "I certify that the shipments identified below have been made, transportation charges have been paid by (company name), and paid freight or comparable receipts are not obtainable.

Contract or Order Number: NNJ06TA25C  
Destination: TBD."

- (b) Government Bills of Lading.

- (1) International (export) and domestic overseas shipments of items deliverable under this contract shall be made by Government bills of lading (GBLs). As used in this clause, "domestic

overseas” means non-continental United States, i.e. Hawaii, Commonwealth of Puerto Rico, and possessions of the United States.

- (2) At least 15 days before shipment, the Contractor shall request in writing GBLs from: Cindy Ratliff, Lead TMS, Contract Transportation, 2101 NASA Parkway, Mail Code JB7, Houston, TX, 77058. If time is limited, requests may be by telephone: 281-483-3208. Requests for GBLs shall include the following information.

- (i) Item identification/ description.
- (ii) Origin and destination.
- (iii) Individual and total weights.
- (iv) Dimensional Weight.
- (v) Dimensions and total cubic footage.
- (vi) Total number of pieces.
- (vii) Total dollar value.
- (viii) Other pertinent data.

(End of clause)

#### **F.4 FLIGHT ITEM (JSC 52.247-95) (SEP 1989)**

Block 16 of each Department of Defense Form 250 prepared for hardware or equipment to be shipped under this contract must be annotated as follows in ¼-inch letters or larger by hand printing or rubber stamp:

‘THIS IS A FLIGHT ITEM: OR “THIS IS MISSION ESSENTIAL GROUND SUPPORT EQUIPMENT,” as applicable.

(End of clause)

#### **F.5 SHIPPING INSTRUCTIONS**

All documentation and hardware to be shipped to JSC shall be shipped as identified below:

Parcel Post Shipments and Freight Shipments

Ship to:	Transportation Officer, Building 421 NASA Johnson Space Center 2101 NASA Parkway Houston, TX 77058-3696
Mark for:	Accountable Property Officer
Mark With:	Contract Number <u>NNJ06TA25C</u>
For reissue to: (Name)	Fred Ouellette
(Mail Code)	ZV
(Bldg.)	17
(Rm.)	252F

Hardware may be required to be shipped to locations other than those identified above in the performance of this contract; the “ship to; mark for; for reissue to” information shall be modified as necessary to annotate the appropriate information for each shipment.

(End of clause)



**F.6 DELIVERABLES**

The Contractor shall make all deliverables as described in Section C, Attachment J-2, Data Requirements Description, of this contract.

(End of clause)

**F.7 OPTION TO EXTEND ORDERING PERIOD**

The Contracting Officer may exercise each of the options listed below by issuance of a unilateral contract modification 30 days or more before the end of the period set forth in clause I.6 "Ordering". Should the option(s) be exercised, the resultant contract will include all terms and conditions of the contract as it exists immediately prior to the exercise of the option(s), except for the following changes:

1. Part (a) of clause I.6 entitled "Ordering" shall be changed to show that orders may be issued from *September 8, 2009 through September 7, 2019.*

(End of clause)

(END OF SECTION)

## SECTION G – CONTRACT ADMINISTRATION DATA

### G.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

#### I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

#### II. NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
1852.227-70	MAY 2002	NEW TECHNOLOGY
1852.227-86	DEC 1987	COMMERCIAL COMPUTER SOFTWARE-- LICENSING
1852.242-71	DEC 1988	TRAVEL OUTSIDE OF THE UNITED STATES
1852.242-73	JUL 2000	NASA CONTRACTOR FINANCIAL MANAGEMENT REPORTING
1852.245-70	JUL 1997	CONTRACTOR REQUESTS FOR GOVERNMENT OWNED EQUIPMENT
1852.245-73	OCT 2003	FINANCIAL REPORTING OF NASA PROPERTY IN THE CUSTODY OF CONTRACTORS (In Paragraph b(3), the NASA office for receipt of NF1018 is: LF631/ Property Accounting and JB3/Property Administrator, 2101 NASA Parkway, Houston, TX 77058)

(End of By Reference Section)

### G.2 SECURITY/BADGING REQUIREMENTS FOR FOREIGN NATIONAL VISITORS AND EMPLOYEES/REPRESENTATIVES OF FOREIGN CONTRACTORS. (JSC 52.204-91) (JAN 2006)

- (a) An employee of a domestic Johnson Space Center (JSC) contractor or its subcontractor who is not a U.S. citizen (foreign national) may not be admitted to the JSC site for purposes of performing work without special arrangements. In addition, all employees or representatives of a foreign JSC contractor/subcontractor may not be admitted to the JSC site without special arrangements. For employees as described above, advance notice must be given to the Security Office of the host

installation [JSC or White Sands Test Facility (WSTF)] at least 3 weeks prior to the scheduled need for access to the site so that instructions on obtaining access may be provided. Contractors should be aware that approval for access to the site and issuance of a badge may take much longer than three weeks and sufficient lead time must be allowed to accommodate the approval process.

- (b) All visit/badge requests for persons described in (a) above must be entered in the NASA Foreign National Management System (NFMNS) for acceptance, review, concurrence and approval purposes. When an authorized company official requests a JSC or WSTF badge for site access, he/she is certifying that steps have been taken to ensure that its contractor or subcontractor employees, visitors, or representatives will not be given access to export-controlled or classified information for which they are not authorized. The authorized company officials shall serve as the contractor's representative(s) in certifying that all visit/badge request forms are processed in accordance with JSC and WSTF security and export control procedures. No foreign national, representative, or resident alien contractor/subcontractor employee shall be granted access into JSC or WSTF until approved and processed through the NFMNS. Unescorted access will not be granted unless a favorable National Agency Check (NAC) has been completed by the JSC Security Office, and an approved NASA Foreign National Visitor Security/Technology Control Plan (STTCP), (previously called the Access Control Plan) has been submitted and approved.
- (c) The contractor agrees that it will not employ for the performance of work onsite at the JSC or WSTF any individuals who are not legally authorized to work in the United States. If the JSC or WSTF Industrial Security Specialist or the contracting officer has reason to believe that any employee of the contractor may not be legally authorized to work in the United States and/or on the contract, the contractor may be required to furnish copies of Form I-9 (Employment Eligibility Verification), U.S. Department of Labor Application for Alien Employment Certification, and any other type of employment authorization document.

The contractor agrees to provide the information requested by the JSC or WSTF Security Office in order to comply with NASA policy directives and guidelines related to foreign visits to NASA facilities so that (1) the visitor/employee/ representative may be allowed access to JSC or other NASA Centers for performance of this contract, (2) required investigations can be conducted, and (3) required annual or revalidation reports can be submitted to NASA Headquarters. All requested information must be submitted in a timely manner in accordance with instructions provided by JSC or any other Center to be visited.

(End of clause)

### **G.3 AWARD FEE FOR SERVICE CONTRACTS (NFS 1852.216-76) (JUN 2000)**

- (a) The contractor can earn award fee from a minimum of zero dollars to the maximum stated in NASA FAR Supplement clause 1852.216-85, "Estimated Cost and Award Fee" in this contract.
- (b) The Government shall evaluate the Contractor's performance every 6 months to determine the amount of award fee earned by the contractor during the period. The Contractor may submit a self-evaluation of performance for each evaluation period under consideration. These self-evaluations will be considered by the Government in its evaluation. The Government's Fee

Determination Official (FDO) will determine the award fee amounts based on the Contractor's performance in accordance with the Award Fee Plan (Attachment J-17). The plan may be revised unilaterally by the Government prior to the beginning of any rating period to redirect emphasis.

- (c) The Government will advise the Contractor in writing of the evaluation results. The payment office listed under NFS 1852.216-87 "SUBMISSION OF VOUCHERS FOR PAYMENT" will make payment based on issuance of unilateral modification by contracting officer.
- (d) After 85 percent of the potential award fee has been paid, the Contracting Officer may direct the withholding of further payment of award fee until a reserve is set aside in an amount that the Contracting Officer considers necessary to protect the Government's interest. This reserve shall not exceed 15 percent of the total potential award fee.
- (e) The amount of award fee which can be awarded in each evaluation period is limited to what is set forth in the Award Fee Plan (Attachment J-17). Award fee which is not earned in an evaluation period cannot be reallocated to future evaluation periods.
- (f) (1) Provisional award fee payments will be made under this contract pending the determination of the amount of fee earned for an evaluation period. If applicable, provisional award fee payments will be made to the Contractor on a monthly basis. The total amount of award fee available in an evaluation period that will be provisionally paid is 50% of award fee available determined at the start of the award fee period.  
  
(2) Provisional award fee payments will be superseded by the final award fee evaluation for that period. If provisional payments exceed the final evaluation score, the Contractor will either credit the next payment voucher for the amount of such overpayment or refund the difference to the Government, as directed by the Contracting Officer.  
  
(3) If the Contracting Officer determines that the Contractor will not achieve a level of performance commensurate with the provisional rate, payment of provisional award fee will be discontinued or reduced in such amounts as the Contracting Officer deems appropriate. The Contracting Officer will notify the Contractor in writing if it is determined that such discontinuance or reduction is appropriate.  
  
(4) Provisional award fee payments will be made prior to the first award fee determination by the Government.
- (g) Award fee determinations are unilateral decisions made solely at the discretion of the Government.

(End of clause)

**G.4 SUBMISSION OF VOUCHERS FOR PAYMENT (NASA 1852.216-87) (MAR 1998)**

- (a) The designated billing office for cost vouchers for purposes of the Prompt Payment clause of this contract is indicated below. Public vouchers for payment of costs shall include a reference to the

number of this contract.

- (b) (1) If the contractor is authorized to submit interim cost vouchers directly to the NASA paying office, the original voucher should be submitted to:

NASA Lyndon B. Johnson Space Center  
Attn: Mail Code LF231  
2101 NASA Parkway  
Houston, TX 77058

(2) For any period that the Defense Contract Audit Agency has authorized the contractor to submit interim cost vouchers directly to the Government paying office, interim vouchers are not required to be sent to the Auditor, and are considered to be provisionally approved for payment, subject to final audit.

(3) Two copies of vouchers should be submitted as directed by the Contracting Officer.

- (c) If the contractor is not authorized to submit interim cost vouchers directly to the paying office as described in paragraph (b), the contractor shall prepare and submit vouchers as follows:

(1) One original Standard Form (SF) 1034, SF 1035, or equivalent contractor's attachment to:

Cognizant DCAA/DCMA Office

(2) Five copies of SF 1034, SF 1035A, or equivalent contractor's attachment to the following offices by insertion in the memorandum block of their names and addresses:

- (i) Copy 1 NASA Contracting Officer
- (ii) Copy 2 Auditor
- (iii) Copy 3 Contractor
- (iv) Copy 4 Contract administration office; and
- (v) Copy 5 Project management office.

(3) The Contracting Officer may designate other recipients as required.

- (d) Public vouchers for payment of fee shall be prepared similarly to the procedures in paragraphs (b) or (c) of this clause, whichever is applicable, and be forwarded to:

NASA Lyndon B. Johnson Space Center  
BT/ Exploration Procurement Office  
Attn: Contract Specialist  
2101 NASA Parkway  
Houston, TX 77058

This is the designated billing office for fee vouchers for purposes of the Prompt Payment clause of this contract.

- (e) In the event that amounts are withheld from payment in accordance with provisions of this contract, a separate voucher for the amount withheld will be required before payment for that amount may be made.

(End of clause)

**G.5 DESIGNATION OF NEW TECHNOLOGY REPRESENTATIVE AND PATENT REPRESENTATIVE (NASA 1852.227-72) (JUL 1997)**

- (a) For purposes of administration of the clause of this contract entitled "New Technology" or "Patent Rights -- Retention by the contractor (Short Form)", whichever is included, the following named representatives are hereby designated by the Contracting Officer to administer such clause:

AT/Technology Transfer & Commercialization Office  
AL/Patent Representative  
NASA Lyndon B. Johnson Space Center  
2101 NASA Parkway  
Houston, TX 77058

- (b) Reports of reportable items, and disclosure of subject inventions, interim reports, final reports, utilization reports, and other reports required by the clause, as well as any correspondence with respect to such matters, should be directed to the New Technology Representative unless transmitted in response to correspondence or request from the Patent Representative. Inquiries or requests regarding disposition of rights, election of rights, or related matters should be directed to the Patent Representative. This clause shall be included in any subcontract hereunder requiring a "New Technology" clause or "Patent Rights--Retention by the contractor (Short Form)" clause, unless otherwise authorized or directed by the Contracting Officer. The respective responsibilities and authorities of the above-named representatives are set forth in 1827.305-370 of the NASA FAR Supplement.

(End of clause)

**G.6 TECHNICAL DIRECTION (NASA 1852.242-70) (SEPT 1993)**

- (a) Performance of the work under this contract is subject to the written technical direction of the Contracting Officer Technical Representative (COTR), who shall be specifically appointed by the Contracting Officer in writing in accordance with NASA FAR Supplement 1842.270. "Technical direction" means a directive to the contractor that approves approaches, solutions, designs, or refinements; fills in details or otherwise completes the general description of work or documentation items; shifts emphasis among work areas or tasks; or furnishes similar instruction to the contractor. Technical direction includes requiring studies and pursuit of certain lines of inquiry regarding matters within the general tasks and requirements in Section C of this contract.
- (b) The COTR does not have the authority to, and shall not, issue any instruction purporting to be technical direction that--
- (1) Constitutes an assignment of additional work outside the statement of work;
  - (2) Constitutes a change as defined in the changes clause;
  - (3) Constitutes a basis for any increase or decrease in the total estimated contract cost, the fixed fee (if any), or the time required for contract performance.

- (4) Changes any of the expressed terms, conditions, or specifications of the contract; or
  - (5) Interferes with the contractor's rights to perform the terms and conditions of the contract.
- (c) All technical direction shall be issued in writing by the COTR.
- (d) The contractor shall proceed promptly with the performance of technical direction duly issued by the COTR in the manner prescribed by this clause and within the COTR's authority. If, in the contractor's opinion, any instruction or direction by the COTR falls within any of the categories defined in paragraph (b) of this clause, the contractor shall not proceed but shall notify the Contracting Officer in writing within 5 working days after receiving it and shall request the Contracting Officer to take action as described in this clause. Upon receiving this notification, the Contracting Officer shall either issue an appropriate contract modification within a reasonable time or advise the contractor in writing within 30 days that the instruction or direction is--
- (1) Rescinded in its entirety; or
  - (2) Within the requirements of the contract and does not constitute a change under the changes clause of the contract, and that the contractor should proceed promptly with its performance.
- (e) A failure of the contractor and contracting officer to agree that the instruction or direction is both within the requirements of the contract and does not constitute a change under the changes clause, or a failure to agree upon the contract action to be taken with respect to the instruction or direction, shall be subject to the Disputes clause of this contract.
- (f) Any action(s) taken by the contractor in response to any direction given by any person other than the Contracting Officer or the COTR shall be at the contractor's risk.

(End of clause)

**G.7 IDENTIFICATION OF EMPLOYEES. (JSC 52.242-92) (JAN 2006)**

At all times while on Government property, the contractor, subcontractors, their employees and agents shall wear badges which will be issued by the NASA Badging & Visitor Control Office, located in Building 110 at the Johnson Space Center (JSC), or at the Main Gate at the White Sands Test Facility (WSTF). JSC employee and visitor badges will be issued only between the hours of 6:00 a.m. to 7:30 p.m., Monday through Friday, and 7:00 am to 4:00 pm on Saturday and Sunday. WSTF employee badges will be issued only between the hours of 8 a.m. to 2 p.m., Monday through Friday. WSTF visitor badges will be issued on a 7-day a week, 24-hour a day basis. Resident aliens and foreign nationals/representatives shall be issued green foreign national badges.

Each individual who wears a badge shall be required to sign personally for the badge. The contractor shall be held accountable for issued badges and all other related items and must assure that they are returned to the NASA Badging & Visitor Control Offices upon completion of work under the contract in accordance with Security Management Directive (SMD) 500-15, "Security Termination Procedures." Failure to comply with the NASA contractor termination procedures upon completion of the work (e.g., return of badges, keys, CAA cards, clearance terminations, JSC Public Key Infrastructure (PKI)/special program deletions, etc.) may result in final payment being delayed.

(End of clause)

**G.8 INSTALLATION-ACCOUNTABLE GOVERNMENT PROPERTY (NFS 1852.245-71)**  
**(NOV 2004)**

- (a) The Government property described in the clause at 1852.245-77, G.10 List of Installation-Accountable Property and Services, shall be made available to the Contractor on a no-charge basis for use in performance of this contract. This property shall be utilized only within the physical confines of the NASA installation that provided the property. Under this clause, the Government retains accountability for, and title to, the property, and the Contractor assumes the following user responsibilities:

The contractor shall establish and adhere to a system of written procedures for compliance with these user responsibilities. Such procedures must include holding employees liable, when appropriate, for loss, damage, or destruction of Government property.

- (b) (1) The official accountable recordkeeping, physical inventory, financial control, and reporting of the property subject to this clause shall be retained by the Government and accomplished by the installation Supply and Equipment Management Officer (SEMO) and Financial Management Officer. If this contract provides for the contractor to acquire property, title to which will vest in the Government, the following additional procedures apply:
- (i) The contractor's purchase order shall require the vendor to deliver the property to the installation central receiving area;
  - (ii) The contractor shall furnish a copy of each purchase order, prior to delivery by the vendor, to the installation central receiving area;
  - (iii) The contractor shall establish a record of the property as required by FAR 45.5 and 1845.5 and furnish to the Industrial Property Officer a DD Form 1149 Requisition and Invoice/Shipping Document (or installation equivalent) to transfer accountability to the Government within 5 working days after receipt of the property by the contractor. The contractor is accountable for all contractor-acquired property until the property is transferred to the Government's accountability.
  - (iv) Contractor use of Government property at an off-site location and off-site subcontractor use require advance approval of the contracting officer and notification of the SEMO. The contractor shall assume accountability and financial reporting responsibility for such property. The contractor shall establish records and property control procedures and maintain the property in accordance with the requirements of FAR Part 45.5 until its return to the installation.
- (2) After transfer of accountability to the Government, the contractor shall continue to maintain such internal records as are necessary to execute the user responsibilities identified in paragraph (a) and document the acquisition, billing, and disposition of the property. These records and supporting documentation shall be made available, upon request, to the SEMO and any other authorized representatives of the contracting officer.



(End of clause)

**G.9 LIST OF GOVERNMENT-FURNISHED PROPERTY (NASA 1852.245-76) (OCT 1988)**

For performance of work under this contract, the Government will make available Government property identified in Attachment J-11 of this contract on a no-charge-for-use basis. The contractor shall use this property in the performance of this contract. Under the FAR 52.245 Government property clause of this contract, the contractor is accountable for the identified property.

(End of clause)

**G.10 LIST OF INSTALLATION-ACCOUNTABLE PROPERTY AND SERVICES (NFS 1852.245-77) (JUL 1997)**

In accordance with the clause at 1852.245-71, G.8 Installation-Accountable Government Property, the Contractor is authorized use of the types of property and services listed below, to the extent they are available, in the performance of this contract within the physical borders of the installation which may include buildings and space owned or directly leased by NASA in close proximity to the installation, if so designated by the Contracting Officer.

- (a) Office space, work area space, and utilities. Government telephones are available for official purposes only; pay telephones are available for contractor employees for unofficial calls.
- (b) General- and special-purpose equipment, including office furniture.
  - (1) Equipment to be made available is listed in Attachment J-10. The Government retains accountability for this property under the clause at 1852.245-71, G.8 Installation-Accountable Government Property, regardless of its authorized location.
  - (2) If the Contractor acquires property, title to which vests in the Government pursuant to other provisions of this contract, this property also shall become accountable to the Government upon its entry into Government records as required by the clause at 1852.245-71, G.8 Installation-Accountable Government Property.
  - (3) The Contractor shall not bring to the installation for use under this contract any property owned or leased by the Contractor, or other property that the Contractor is accountable for under any other Government contract, without the Contracting Officer's prior written approval.
- (c) Supplies from stores stock.
- (d) Publications and blank forms stocked by the installation.
- (e) Safety and fire protection for Contractor personnel and facilities.
- (f) Installation service facilities: See Attachment J-10

- (g) Medical treatment of a first-aid nature for Contractor personnel injuries or illnesses sustained during on-site duty.
- (h) Cafeteria privileges for Contractor employees during normal operating hours.
- (i) Building maintenance for facilities occupied by Contractor personnel.
- (j) Moving and hauling for office moves, movement of large equipment, and delivery of supplies.  
Moving services shall be provided on-site, as approved by the Contracting Officer.
- (k) The user responsibilities of the Contractor are defined in paragraph (a) of the clause at 1852.245-71, Installation-Accountable Government Property.

(End of clause)

(END OF SECTION)

## **SECTION H - SPECIAL CONTRACT REQUIREMENTS**

### **H.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE**

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

#### **I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
None		

#### **II. NASA FEDERAL ACQUISITION REGULATION SUPPLEMENT (48 CFR CHAPTER 18)**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
1852.208-81	NOV 2004	RESTRICTIONS ON PRINTING AND DUPLICATING
1852.223-70	APR 2002	SAFETY AND HEALTH
1852.223-75	FEB 2002	MAJOR BREACH OF SAFETY OR SECURITY
1852.223-76	JUL 2003	FEDERAL AUTOMOTIVE STATISTICAL TOOL REPORTING
1852.225-70	FEB 2000	EXPORT LICENSES (Insert "NASA facilities" in paragraph (b))
1852.228-76	DEC 1994	CROSS WAIVER OF LIABILITY FOR SPACE STATION ACTIVITIES
1852.242-72	AUG 1992	OBSERVANCE OF LEGAL HOLIDAYS (ALT II) (NOV 2000) (ALT I)(SEP 1989)
1852.244-70	APR 1985	GEOGRAPHIC PARTICIPATION IN THE AEROSPACE PROGRAM
1852.246-70	MAR 1997	MISSION CRITICAL SPACE SYSTEM PERSONNEL RELIABILITY PROGRAM

(End of By Reference Section)

#### **H.2 REPRESENTATION, CERTIFICATION, AND OTHER STATEMENTS (JSC 52.209-90) (SEP 1988)**

This contract incorporates Section K, Representations, Certifications, and Other Statements of Offerors, as set forth in the contractor's proposal number P06-460570 dated 21 July 2006 by reference, with the same force and effect as if it were given in full text.

(End of clause)

### **H.3 SPECIAL PROVISION FOR CONTRACT CHANGES**

The parties agree that, notwithstanding the provisions of the "Changes" clause and the "Government Property" clause, no change made pursuant to the "Changes" clause shall give rise to an equitable adjustment in the estimated cost or fee or any other contract provision when said change causes an increase or decrease of **\$1,000,000** or less in the estimated cost of this contract. Each change shall be controlling in making this determination, and such change shall not, for purposes of determining the applicability of this clause, be added to any other change(s). The parties recognize that several changes may be grouped together in a bilateral modification for definitization; however, the dollar value of each individual change will be controlling in determining whether or not an equitable adjustment is in order.

(End of clause)

### **H.4 SUBCONTRACTING WITH RUSSIAN ENTITIES FOR GOODS OR SERVICES**

(a) Definitions: In this provision:

i) The term "Russian entities" includes the following:

- (1) The Russian Federal Space Agency (Roscosmos),
- (2) Any organization or entity under the jurisdiction or control of Roscosmos, or
- (3) Any other organization, entity, or element of the Government of the Russian Federation.

ii) The term "Organization or entity under the jurisdiction or control of Roscosmos" means an organization or entity that:

- (1) Was made part of the Russian Federal Space Agency upon its establishment on February 25, 1992;
- (2) Was transferred to the Russian Federal Space Agency by decree of the Russian Government on July 25, 1994, or May 12, 1998;
- (3) Was or is transferred to the Russian Aviation and Space Agency or Russian Federal Space Agency by decree of the Russian Government at any other time before, on, or after March 14, 2000; or
- (4) Is a joint stock company in which the Russian Aviation and Space Agency or Russian Federal Space Agency has at any time held controlling interest.

iii) The term "extraordinary payments" means payments in cash or in kind made or to be made by the United States Government prior to January 1, 2012, for work to be performed or services to be rendered prior to that date necessary to meet United States obligations under the Agreement Concerning Cooperation on the Civil International Space Station, with annex, signed at Washington January 29, 1998, and entered into force March 27, 2001, or any protocol, agreement, memorandum of understanding, or contract related thereto.

(b) This clause implements the Iran and Syria Nonproliferation Act (the Iran Nonproliferation Act as amended by the Iran Nonproliferation Amendments Act of 2005) to allow extraordinary payments prior to January 1, 2012 to Russian entities in connection with the International Space Station.

NASA has applied the restrictions in the Act to include funding of Russian entities via U.S. contractors.

(c) (i) The Contractor shall not subcontract with Russian entities without first receiving written approval from the Contracting Officer. In order to obtain this written approval to subcontract with any Russian entity as defined in paragraphs (a), the Contractor shall provide the Contracting Officer with the following information related to each planned new subcontract and any change to an existing subcontract with entities that fit the description in paragraphs (a):

- (1) A detailed description of the subcontracting entity, including its name, address, and a point of contact, as well as a detailed description of the proposed subcontract including the specific purpose of payments that will be made under the subcontract.
- (2) The contractor shall provide certification that the subcontracting entity is not on any of the denied parties, specially designated nationals and entities of concern lists found at:  
<http://www.hq.nasa.gov/office/oer/nasaecp/Welcome.html>

**Denied Parties, Specially Designated Nationals and Entities of Concern**

BIS's Listing of Entities of Concern UPDATED

BIS's List of Denied Parties UPDATED

Debarred Parties Listing

OFAC's List of Specially Designated Nationals *(Adobe PDF format)*

List of Unverified Persons in Foreign Countries UPDATED

(ii) Unless relief is granted by the Contracting Officer, the information necessary to obtain approval to subcontract shall be provided to the Contracting Officer 30 business days prior to executing any planned subcontract with entities defined in paragraph (a).

(d) After receiving approval to subcontract, the contractor shall provide the Contracting Officer with a report every six-months which documents the individual extraordinary payments made to an entity in paragraph a. The reports are due on July 15<sup>th</sup> and January 15<sup>th</sup>. The July 15<sup>th</sup> report should document all of the individual extraordinary payments made from the previous January through June. The January 15<sup>th</sup> report should document all of the individual extraordinary payments made from the previous July through December. The content of the report shall provide the following information for each time an extraordinary payment is made to an entity in paragraph a:

- (i) The name of the entity
- (ii) The subcontract number
- (iii) The amount of the payment
- (iv) The date of the payment

(e) The Contracting Officer may direct the Contractor to provide additional information for any other prospective or existing subcontract at any tier. The Contracting Officer may direct the Contractor to terminate for the convenience of the government any subcontract at any tier with an entity described in paragraphs (a), subject to an equitable adjustment.

- (f) Notwithstanding FAR 52.216-7, "Allowable Cost and Payments," on or after January 1, 2012 the contractor shall be responsible to make payments to entities defined in paragraphs (a) of this provision. Any subcontract with entities defined in paragraph (a), therefore, should be completed in sufficient time to permit the U.S. Government to make extraordinary payments on subcontracts with Russian entities on or before December 31, 2011.
- (g) The Contractor shall include the substance of this clause in all its subcontracts, and shall require such inclusion in all other subcontracts of any tier. The Contractor shall be responsible to obtain written approval from the Contracting Officer to enter into any tier subcontract that involves entities defined in paragraph (a).

(End of clause)

#### **H.5 COMPLIANCE WITH APPLICABLE CENTER POLICIES AND PROCEDURES**

Contractor and subcontractor personnel (regardless of tier) working on-site at NASA Centers shall comply with all applicable center policies and procedures. The contractor shall keep itself and pertinent subcontractors up-to-date with the latest revisions of these policies and procedures. The contractor shall promptly take corrective action upon receipt of notice from the Contracting Officer of noncompliance with any applicable center policy or procedure.

#### **H.6 RESERVED**

(End of clause)

#### **H.7 INDEMNIFICATION FOR UNUSUALLY HAZARDOUS RISKS**

a) The Government recognizes that the Contractor's approach to fulfill the requirements of this contract might involve conditions considered to constitute unusually hazardous risks resulting in potential third party liability exceeding insurance coverage the Contractor could reasonably be expected to purchase and maintain, considering the availability, cost, and terms and conditions of such insurance. In the event the Contractor believes such conditions exist and necessitate indemnification by the Government, the Contractor shall provide documentation and rationale adequate to substantiate processing of such requests in accordance with applicable laws and regulations. The Contractor shall furnish the information required in accordance with FAR 50.403-1 and NASA FAR Supplement 1850.403. Reference to these FAR and NASA FAR Supplement sections is not an indication that NASA has determined indemnification to be applicable. The Contractor's request for indemnification must explain under what authority NASA can provide indemnification for unusually hazardous risks associated with performance of the contract. In addition to identifying a sufficient legal basis for indemnification, the Contractor's request for indemnification also must substantiate a sufficient factual basis for indemnification by explaining specifically what work under the contract poses unusually hazardous risks.

b) The Government will consider a request for indemnification for unusually hazardous risks in accordance with the foregoing paragraph. In the event the Government denies the Contractor's request for indemnification, the parties will enter into good faith negotiations to determine the appropriate course of action concerning potential third party liability.

(End of clause)

**H.8 RESERVED**

(End of clause)

**H.9 RESERVED**

(End of clause)

**H.10 PATENT RIGHTS**

This contract includes the New Technology Clause 1852.227-70. It is anticipated that the Contractor may have Contractor background inventions that could be applied to Contract research and incorporated into deliverables under the Contract. The Government may need rights to use such Contractor background inventions in order to practice technologies produced under this Contract in other Government contracts. Thus, Contracting Officer permission is required before Contractor background inventions may be included in Contract deliverables. To the extent a contractor background invention has been Federally funded, the Government will receive its government-purpose license rights to practice the background invention. Where there is no Federal funding of the background invention, the Contractor will identify to the Contracting Officer the rights that it proposes to grant the Government to use such invention in other Government contracts. The Government shall receive a government-purpose license to practice any contractor background invention where such Contracting Officer permission is not obtained prior to incorporating its background inventions into Contractor work. This clause or a clause substantially the same shall be included in all subcontracts at any tier.

(End of clause)

**H.11 TASK ORDERING PROCEDURE (NFS 1852.216-80) (OCT 1996)**

- (a) Only the Contracting Officer may issue task orders to the Contractor, providing specific authorization or direction to perform work within the scope of the contract and as specified in the schedule. The Contractor may incur costs under this contract in performance of task orders and task order modifications issued in accordance with this clause. No other costs are authorized unless otherwise specified in the contract or expressly authorized by the Contracting Officer.
- (b) Prior to issuing a task order, the Contracting Officer shall provide the Contractor with the following data:
  - 1) A functional description of the work identifying the objectives or results desired from the contemplated task order.
  - 2) Proposed performance standards to be used as criteria for determining whether the work requirements have been met.
  - 3) A request for a task plan from the Contractor to include the technical approach, period of performance, appropriate cost information, and any other information required to determine the reasonableness of the Contractor's proposal.
- (c) Within 30 calendar days after receipt of the Contracting Officer's request, the Contractor shall submit a task plan conforming to the request.

- (d) After review and any necessary discussions, the Contracting Officer may issue a task order to the Contractor containing, as a minimum, the following:
- (1) Date of the order.
  - (2) Contract number and order number.
  - (3) Functional description of the work identifying the objectives or results desired from the task order, including special instructions or other information necessary for performance of the task.
  - (4) Performance standards, and where appropriate, quality assurance standards.
  - (5) Maximum dollar amount authorized (cost and fee or price). This includes allocation of award fee among award fee periods, if applicable.
  - (6) Any other resources (travel, materials, equipment, facilities, etc.) authorized.
  - (7) Delivery/performance schedule including start and end dates.
  - (8) If contract funding is by individual task order, accounting and appropriation data.
- (e) The Contractor shall provide acknowledgment of receipt to the Contracting Officer within 5 calendar days after receipt of the task order.
- (f) If time constraints do not permit issuance of a fully defined task order in accordance with the procedures described in paragraphs (a) through (d), a task order which includes a ceiling price may be issued.
- (g) The Contracting Officer may amend tasks in the same manner in which they were issued.
- (h) In the event of a conflict between the requirements of the task order and the Contractor's approved task plan, the task order shall prevail.

(End of clause)

## **H.12 ELECTRONIC DATA ACCESS**

The Contractor shall implement and maintain an Electronic Data Access (EDA) with the Government utilizing web-enabled technology at the Unclassified, For Official Use Only (FOUO), and Contractor Proprietary levels during the CEV Phase 2 contract. The EDA shall establish and maintain the capability for access to the contracting management information system, working data, including subcontractor data, developed to support the management and engineering efforts of the project. The Government will provide a list of authorized personnel for full electronic access to the contractor's database after contract award. The Contractor's database shall be compatible with typical Government PC-based systems using the MS Office 2000 suite of applications (e.g. Word, Excel, PowerPoint, and Project) as well as Adobe Acrobat 7.0. The Contractor shall establish the aforementioned EDA system capable of fully supporting government access information within thirty (30) calendar days of contract start.

(End of clause)



### **H.13 SPACE FLIGHT MOTIVATION AWARENESS PROGRAM**

The Contractor shall establish a program for Space Flight Awareness (SFA). The Program's goals and objectives are to:

- Ensure every employee involved in human space flight is aware of the importance of their role in promoting safety, quality and mission success.
- Participation in NASA-Industry Space Flight Awareness Program.
- Increase awareness of the Human Space Flight Program accomplishments, milestones and objectives with a focus on safety and mission success.
- Conduct events and products that motivate and recognize the workforce, and enhance employee morale.
- Function as an internal communications team to disseminate key educational, program/management safety, quality, and mission success messages and themes.

(End of clause)

### **H.14 SMALL BUSINESS SUBCONTRACTING GOALS**

In meeting the intent of Small /Disadvantaged business participation under this contract, the Contractor agrees to flow down to all first-tier large business subcontractors, as percentages (with corresponding dollar amounts) of their total contract value the same socioeconomic goals agreed to under the prime Contractor subcontracting plan. The Contractor agrees to flow down the goals to other tier large business subcontractors.

(End of clause)

### **H.15 SUBCONTRACTOR SMALL BUSINESS REPORTING**

Contractor shall require first-tier large business subcontractors to report lower-tier Small Business Concern subcontracting dollars on a semi-annual basis. This reporting is conducted through the Electronic Subcontracting Reporting Systems (eSRS) located at <http://www.esrs.gov>.

(End of clause)

### **H.16 KEY PERSONNEL AND FACILITIES (NASA 1852.235-71) (MAR 1989)**

- (a) The personnel and/or facilities listed below (or specified in the contract Schedule) are considered essential to the work being performed under this contract. Before removing, replacing, or diverting any of the listed or specified personnel or facilities, the Contractor shall (1) notify the Contracting

Officer reasonably in advance and (2) submit justification (including proposed substitutions) in sufficient detail to permit evaluation of the impact on this contract.

- (b) The Contractor shall make no diversion without the Contracting Officer's written consent; provided, that the Contracting Officer may ratify in writing the proposed change, and that ratification shall constitute the Contracting Officer's consent required by this clause.
- (c) The list of personnel and/or facilities (shown below or as specified in the contract Schedule) may, with the consent of the contracting parties, be amended from time to time during the course of the contract to add or delete personnel and/or facilities.

<u>NAME</u>	<u>TITLE</u>
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(End of clause)

#### **H.17 ASSOCIATE CONTRACTOR AGREEMENTS**

- (a) In order to achieve the requirements of this contract, the Contractor shall establish, in conjunction with the CEV Project Office, the means for coordination and exchange of information with associate contractors. The information to be exchanged shall be that required by the contractors in the execution of their respective contract requirements. The associate contractors contemplated by this clause have not been established at the time of contract award, but will be added by contract modification to this paragraph as required. The associate contractors will supply other elements of the Constellation program, such as a launch vehicle, earth departure stage, or lunar surface access module.
- (b) The Contractor shall document agreements with other associate contractors described in (a) above via associate contractor agreements. The Government will not be a party in such associate contractor agreements. A copy of each such agreement shall be provided to the Contracting Officer. All costs associated with such agreements are included in the negotiated cost of this contract.
- (c) The contractor is not relieved of any contract requirements or entitled to any adjustments to the contract terms because of the failure to resolve a disagreement with an associate contractor. Liability for the improper disclosure of any proprietary data contained in or referenced by any agreement shall rest with the parties to the agreement, and not the Government.

(End of clause)

#### **H.18 DATA DELIVERABLE MARKING REQUIREMENTS FOR EXPORT CONTROL**

- (a) The contractor shall perform an export control assessment for all data deliverable items shown in Attachment J-2, Data Procurement Document.

- (b) If a product is determined to contain information controlled by the International Traffic in Arms Regulations, the following statement shall be included on the product cover page.

**International Traffic in Arms Regulations (ITAR) Notice**

This document contains information on paragraphs [list specific pages subject to ITAR control] falls under the purview of the U.S. Munitions List (USML), as defined in the International Traffic in Arms Regulations (ITAR), 22 CFR 120-130, and is export controlled. It shall not be transferred to foreign nationals in the U.S. or abroad, without specific approval of a knowledgeable NASA export control official, and/or unless an export license/license exemption is obtained/available from the United States Department of State. Violations of these regulations are punishable by fine, imprisonment, or both.

- (c) If a product is determined to contain information controlled by the Export Administration Regulations and which requires a license or exception prior to export, the following statement shall be included on the product cover page:

**Export Administration Regulations (EAR) Notice**

This document contains information on [list specific pages subject to the EAR] within the purview of the Export Administration Regulations (EAR), 15 CFR 730-744, and is export controlled. It may not be transferred to foreign nationals in the U.S. or abroad, without specific approval of a knowledgeable NASA export control official, and/or unless an export license/license exception is obtained/available from the Bureau of Industry and Security (BIS), United States Department of Commerce. Violations of these regulations are punishable by fine, imprisonment, or both.

- d) If a product has been determined to be suitable for public release it shall be so labeled.

(End of clause)

**H.19 APPLICATION OF U.S. SPACE TRANSPORTATION POLICY**

All effort under this contract shall be consistent with the National Security Presidential Directive/NSPD-40 (U.S. Space Transportation Policy.)

(End of clause)

**H.20 COMPLIANCE WITH APPLICABLE ELECTRONIC AND INFORMATION TECHNOLOGY (EIT) POLICIES**

The contractor shall aid NASA CEV Project office in the preparation of Information Technology reporting and documentations. The contractor agrees to produce for NASA/CEV Project Office documents related to NPR 2810.1, Security of Information Technology. The contractor further agrees to aid NASA in documentation related to OMB circular A-11, Preparation, submission, and Execution of Budget; OMB A-130, Management of Federal Information; Exhibit 53, List of IT Costs and Budget Items; and Exhibit 300, capital Asset Plan Reports on Major IT Investments.

(End of clause)

**H.21 LIMITATION OF FUTURE CONTRACTING (NFS 1852.209-71) (DEC 1988)**

- (a) The Contracting Officer has determined that this acquisition may give rise to a potential organizational conflict of interest. Accordingly, the attention of prospective offerors is invited to FAR Subpart 9.5--Organizational Conflicts of Interest.
- (b) The nature of this conflict is the Contractor may be in a position to favor its own products and capabilities and may have an unfair competitive advantage.
- (c) The restrictions upon future contracting are as follows:
  - (1) If the Contractor, under the terms of this contract, or through the performance of tasks pursuant to this contract, is required to develop specifications or statements of work that are to be incorporated into a solicitation, the Contractor shall be ineligible to perform the work described in that solicitation as a prime or first-tier subcontractor under an ensuing NASA contract. This restriction shall remain in effect for a reasonable time, as agreed to by the Contracting Officer and the Contractor, sufficient to avoid unfair competitive advantage or potential bias (this time shall in no case be less than the duration of the initial production contract). NASA shall not unilaterally require the Contractor to prepare such specifications or statements of work under this contract.
  - (2) To the extent that the work under this contract requires access to proprietary, business confidential, or financial data of other companies, and as long as these data remain proprietary or confidential, the Contractor shall protect these data from unauthorized use and disclosure and agrees not to use them to compete with those other companies.

(End of clause)

**H.22 ADVANCE AGREEMENT FOR CONTRACTOR INVESTMENTS**

The parties agree that the contract might be partly based on corporate contributions/investment as specified in the proposal or as negotiated in the contract. Costs related to the Contractor's contributions or investments shall be reported under the contract as they are incurred, for purposes of tracking the Contractor's costs as well as the full costs of the project. The Contractor agrees that, should the Government's requirements change or should all or part of the work under the contract be terminated, all reported costs as well as unreported costs related to the Contractor's contributions and investment will be unallowable as part of any contract settlement.

(End of clause)

[END OF SECTION]

## PART II - CONTRACT CLAUSES

### SECTION I - CONTRACT CLAUSES

#### I.1 LISTING OF CLAUSES INCORPORATED BY REFERENCE

NOTICE: The following contract clauses pertinent to this section are hereby incorporated by reference:

#### I. FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1)

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
52.202-1	JUL 2004	DEFINITIONS
52.203-3	APR 1984	GRATUITIES
52.203-5	APR 1984	COVENANT AGAINST CONTINGENT FEES
52.203-6	JUL 1995	RESTRICTIONS ON SUBCONTRACTOR SALES TO THE GOVERNMENT
52.203-7	JUL 1995	ANTI-KICKBACK PROCEDURES
52.203-8	JAN 1997	CANCELLATION, RESCISION, AND RECOVERY OF FUNDS FOR ILLEGAL OR IMPROPER ACTIVITY
52.203-10	JAN 1997	PRICE OR FEE ADJUSTMENT FOR ILLEGAL OR IMPROPER ACTIVITY
52.203-12	JUN 2003	LIMITATION ON PAYMENTS TO INFLUENCE CERTAIN FEDERAL TRANSACTIONS
52.204-2	AUG. 1996	SECURITY REQUIREMENTS
52.204-4	AUG 2000	PRINTING/COPYING DOUBLE SIDED ON RECYCLED PAPER
52.204-7	OCT 2003	CENTRAL CONTRACTOR REGISTRATION
52.204-9	JAN 2006	PERSONAL IDENTITY VERIFICATION OF CONTRACTOR PERSONNEL (Please see Attachment J-19 PIV Card Issuance Procedures)
52.209-6	JAN 2005	PROTECTING THE GOVERNMENT'S INTEREST WHEN SUBCONTRACTING WITH CONTRAC-TORS DEBARRED, SUSPENDED, OR PROPOSED FOR DEBARMENT
52.211-5	AUG 2000	MATERIAL REQUIREMENTS
52.211-15	SEPT 1990	DEFENSE PRIORITY AND ALLOCATION REQUESTS
52.215-2	JUNE 1999	AUDIT AND RECORDS--NEGOTIATION
52.215-8	OCT 1997	ORDER OF PRECEDENCE--UNIFORM CONTRACT

		FORMAT
52.215-10	OCT 1997	PRICE REDUCTION FOR DEFECTIVE COST OR PRICING DATA
52.215-11	OCT 1997	PRICE REDUCTION FOR DEFECTIVE COST OR PRICING DATA-- MODIFICATIONS
52.215-12	OCT 1997	SUBCONTRACTOR COST OR PRICING DATA
52.215-13	OCT 1997	SUBCONTRACTOR COST OR PRICING DATA - MODIFICATIONS
52.215-14	OCT 1997	INTEGRITY OF UNIT PRICES
52.215-15	OCT 2004	PENSION ADJUSTMENTS AND ASSET REVERSIONS
52.215-18	JUL 2005	REVERSION OR ADJUSTMENT OF PLANS FOR POSTRETIREMENT BENEFITS (PRB) OTHER THAN PENSIONS
52.215-19	OCT 1997	NOTIFICATION OF OWNERSHIP CHANGES
52.215-21	OCT 1997	REQUIREMENTS FOR COST OR PRICING DATA OR INFORMATION OTHER THAN COST OR PRICING DATA—MODIFICATIONS (ALT II) (OCT 1997) (ALT III) (OCT 1997) Insert (d) Electronic media: <u>Microsoft Office ®</u>
52.216-7	DEC 2002	ALLOWABLE COST AND PAYMENT
52.217-7	MAR 1989	OPTION FOR INCREASED QUANTITY-SEPERATELY PRICED LINE ITEM
52.219-8	MAY 2005	UTILIZATION OF SMALL BUSINESS CONCERNS
52.219-9	JUL 2005	SMALL BUSINESS SUBCONTRACTING PLAN (ALT II) (OCT 2001)
52.219-16	JAN 1999	LIQUIDATED DAMAGES—SUBCONTRACTING PLAN
52.219-25	OCT 1999	SMALL DISADVANTAGED BUSINES PARTICIPATION PROGRAM- DISADVANTAGED STATUS AND REPORTING
52.222-1	FEB 1997	NOTICE TO THE GOVERNMENT OF LABOR DISPUTES
52.222-3	JUN 2003	CONVICT LABOR
52.222-4	JUL 2005	CONTRACT WORK HOURS AND SAFETY STANDARDS ACT-OVERTIME COMPENSATION
52.222-20	DEC 1996	WALSH-HEALEY PUBLIC CONTRACTS ACT
52.222-21	FEB 1999	PROHIBITION OF SEGREGATED FACILITIES
52.222-26	APR 2002	EQUAL OPPORTUNITY
52.222-35	DEC 2001	EQUAL OPPORTUNITY FOR SPECIAL DISABLED VETERANS, VETERANS OF THE VIETNAM ERA, AND OTHER ELIGIBLE VETERANS

52.222-36	JUN 1998	AFFIRMATIVE ACTION FOR WORKERS WITH DISABILITIES
52.222-37	DEC 2001	EMPLOYMENT REPORTS ON SPECIAL DISABLED VETERANS, VETERANS OF THE VIETNAM ERA, AND OTHER ELIGIBLE VETERANS
52.222-39	DEC 2004	NOTIFICATION OF EMPLOYEE RIGHTS CONCERNING PAYMENT OF UNION DUES OR FEES
52.223-3	JAN 1997	HAZARDOUS MATERIAL IDENTIFICATION AND MATERIAL SAFETY DATA (ALT I) (JUL 1995) ( <i>Insert NONE in paragraph b</i> )
52.223-5	AUG 2003	POLLUTION PREVENTION AND RIGHT-TO-KNOW INFORMATION, (ALT I)(AUG 2003), (ALT II)(AUG 2003)
52.223-6	MAY 2001	DRUG-FREE WORKFORCE
52.223-14	AUG 2003	TOXIC CHEMICAL RELEASE REPORTING
52.224-1	APR 1984	PRIVACY ACT
52.225-5	JAN 2005	TRADE AGREEMENTS
52.225-8	FEB 2000	DUTY-FREE ENTRY
52.225-13	MAR 2005	RESTRICTIONS ON CERTAIN FOREIGN PURCHASES
52.227-1	JUL 1995	AUTHORIZATION AND CONSENT (ALT I) (APR 1984)
52.227-2	AUG 1996	NOTICE AND ASSISTANCE REGARDING PATENT AND COPYRIGHT INFRINGEMENT
52.227-16	JUN 1987	ADDITIONAL DATA REQUIREMENTS
52.227-21	JAN 1997	TECHNICAL DATA DECLARATION, REVISION, AND WITHHOLDING OF PAYMENT-MAJOR SYSTEMS (Offeror to fill in (if appropriate) (b)(1).)
52.228-7	MAR 1996	INSURANCE--LIABILITY TO THIRD PERSONS
52.230-2	APR 1998	COST ACCOUNTING STANDARDS
52.230-6	NOV 1999	ADMINISTRATION OF COST ACCOUNTING STANDARDS
52.232-17	JUN 1996	INTEREST
52.232-18	APR 1984	AVAILABILITY OF FUNDS
52.232-22	APR 1984	LIMITATION OF FUNDS
52.232-23	JAN 1986	ASSIGNMENT OF CLAIMS
52.232-25	OCT 2003	PROMPT PAYMENT
52.232-34	MAY 1999	PAYMENT BY ELECTRONIC FUNDS TRANSFER--OTHER THAN CENTRAL CONTRACTOR REGISTRATION ( <i>Insert in paragraph (b)(1) "no later than concurrent with the first request for payment".</i> )

52.233-1	JULY 2002	DISPUTES (ALT I) (DEC 1991)
52.233-3	AUG 1996	PROTEST AFTER AWARD (ALT I) (JUN 1985)
52.233-4	OCT 2004	APPLICABLE LAW FOR BREACH OF CONTRACT CLAIM
52.237-2	APR 1984	PROTECTION OF GOVERNMENT BUILDINGS, EQUIPMENT, AND VEGETATION
52.242-1	APR 1984	NOTICE OF INTENT TO DISALLOW COSTS
52.242-3	MAY 2001	PENALTIES FOR UNALLOWABLE COSTS
52.242-4	JAN 1997	CERTIFICATION OF FINAL INDIRECT COSTS
52.242-13	JUL 1995	BANKRUPTCY
52.243-2	AUG 1987	CHANGES--COST-REIMBURSEMENT (ALT II) (APR 1984)
52.243-6	APR 1984	CHANGE ORDER ACCOUNTING
52.243-7	APR 1984	NOTIFICATION OF CHANGES
52.244-2	AUG 1998	SUBCONTRACTS (ALT I) (MAR 2005) (Insert "All foreign subcontracts, other subcontracts greater than \$50 Million, and any subcontracts with Limited Data Rights" in paragraph (e) and insert "none" in paragraph (k))
52.244-5	DEC 1996	COMPETITION IN SUBCONTRACTING
52.244-6	DEC 2004	SUBCONTRACTS FOR COMMERCIAL ITEMS
52.245-1	APR 1984	PROPERTY RECORDS
52.245-5	MAY 2004	GOVERNMENT PROPERTY (COST-REIMBURSEMENT, TIME-AND-MATERIAL, OR LABOR-HOUR CONTRACTS) (DEVIATION) (AS MODIFIED BY NASA PIC 04-12) ) (See attachment J-11)
52.245-17	MAY 2004	SPECIAL TOOLING
52.245-18	FEB 1993	SPECIAL TEST EQUIPMENT
52.246-24	FEB 1997	LIMITATION OF LIABILITY – HIGH VALUE ITEMS, (ALT I) (APR 1984)
52.247-1	APR 1984	COMMERCIAL BILL OF LADING NOTATIONS
52.247-63	JUN 2003	PREFERENCE FOR U.S.-FLAG AIR CARRIERS
52.248-1	FEB 2000	VALUE ENGINEERING
52.249-6	MAY 2004	TERMINATION (COST-REIMBURSEMENT)



52.249-14	APR 1984	EXCUSABLE DELAYS
52.251-1	APR 1984	GOVERNMENT SUPPLY SOURCES
52.251-2	JAN 1991	INTERAGENCY FLEET MANAGEMENT SYSTEMS VEHICLES AND RELATED SERVICES
52.253-1	JAN 1991	COMPUTER GENERATED FORMS

## **II. NASA FAR SUPPLEMENT (48 CFR CHAPTER 18) PROVISIONS**

<u>CLAUSE NUMBER</u>	<u>DATE</u>	<u>TITLE</u>
1852.203-70	JUN 2001	DISPLAY OF INSPECTOR GENERAL HOTLINE POSTERS
1852.216-89	JUL 1997	ASSIGNMENT AND RELEASE FORMS
1852.219-74	SEPT 1990	USE OF RURAL AREA SMALL BUSINESSES
1852.219-75	MAY 1999	SMALL BUSINESS SUBCONTRACTING REPORTING
1852.219-76	JUL 1997	NASA 8 PERCENT GOAL
1852.223-74	MAR 1996	DRUG-AND ALCOHOL-FREE WORKFORCE
1852.227-86	DEC 1987	COMMERCIAL COMPUTER SOFTWARE--LICENSING
1852.227-87	APR 1989	TRANSFER OF TECHNICAL DATA UNDER SPACE STATION INTERNATIONAL AGREEMENTS
1852.228-75	OCT 1988	MINIMUM INSURANCE COVERAGE
1852.235-70	FEB 2003	CENTER FOR AEROSPACE INFORMATION
1852.237-70	DEC 1988	EMERGENCY EVACUATION PROCEDURES
1852.237-72	JUN 2005	ACCESS TO SENSITIVE INFORMATION
1852.237-73	JUN 2005	RELEASE OF SENSITIVE INFORMATION
1852.242-78	APR 2001	EMERGENCY MEDICAL SERVICES AND EVACUATION
1852.243-71	MAR 1997	SHARED SAVINGS

(End of By Reference Section)

### **I. 2 APPROVAL OF CONTRACT (FAR 52.204-1) (DEC 1989)**

This contract is subject to the written approval of the JSC Procurement Officer and shall not be binding until so approved.

(End of clause)

**I.3 SECURITY CLASSIFICATION REQUIREMENTS (1852.204-75) (SEPT 1989)**

Performance under this contract will involve access to and/or generation of classified information, work in a security area, or both, up to the level of "secret". See Federal Acquisition Regulation clause 52.204-2 in this contract and DD Form 254, Contract Security Classification Specification, Attachment J-20.

(End of clause)

**I.4 SECURITY REQUIREMENTS FOR UNCLASSIFIED INFORMATION TECHNOLOGY RESOURCES (NASA 1852.204-76) (NOV 2004)**

- a) The Contractor shall be responsible for Information Technology security for all systems connected to a NASA network or operated by the Contractor for NASA, regardless of location. This clause is applicable to all or any part of the contract that includes information technology resources or services in which the Contractor must have physical or electronic access to NASA's sensitive information contained in unclassified systems that directly support the mission of the Agency. This includes information technology, hardware, software, and the management, operation, maintenance, programming, and system administration of computer systems, networks, and telecommunications systems. Examples of tasks that require security provisions include:
- (1) Computer control of spacecraft, satellites, or aircraft or their payloads;
  - (2) Acquisition, transmission or analysis of data owned by NASA with significant replacement cost should the contractor's copy be corrupted; and
  - (3) Access to NASA networks or computers at a level beyond that granted the general public, e.g. bypassing a firewall.
- b) The Contractor shall provide, implement, and maintain an IT Security Plan. This plan shall describe the processes and procedures that will be followed to ensure appropriate security of IT resources that are developed, processed, or used under this contract. The plan shall describe those parts of the contract to which this clause applies. The Contractor's IT Security Plan shall be compliant with Federal laws that include, but are not limited to, the Computer Security Act of 1987 (40 U.S.C. 1441 et seq.) and the Government Information Security Reform Act of 2000. The plan shall meet IT security requirements in accordance with Federal and NASA policies and procedures that include, but are not limited to:
- (1) OMB Circular A-130, Management of Federal Information Resources, Appendix III, Security of Federal Automated Information Resources;
  - (2) NASA Procedures and Guidelines (NPR) 2810.1, Security of Information Technology; and
  - (3) Chapter 3 of NPR 1620.1, NASA Security Procedural Requirements.
- c) Within 45 calendar days after contract award, the contractor shall submit for NASA approval an IT Security Plan. This plan must be consistent with and further detail the approach contained in the offeror's proposal or sealed bid that resulted in the award of this contract and in compliance with the requirements stated in this clause. The plan, as approved by the Contracting Officer, shall be incorporated into the contract as a compliance document.

- d)(1) Contractor personnel requiring privileged access or limited privileged access to systems operated by the Contractor for NASA or interconnected to a NASA network shall be screened at an appropriate level in accordance with NPR 2810.1, Section 4.5; NPR 1620.1, Chapter 3; and paragraph (d)(2) of this clause. Those Contractor personnel with non-privileged access do not require personnel screening. NASA shall provide screening using standard personnel screening National Agency Check (NAC) forms listed in paragraph (d)(3) of this clause, unless contractor screening in accordance with paragraph (d)(4) is approved. The Contractor shall submit the required forms to the NASA Center Chief of Security (CCS) within fourteen (14) days after contract award or assignment of an individual to a position requiring screening. The forms may be obtained from the CCS. At the option of the government, interim access may be granted pending completion of the NAC.
- (2) Guidance for selecting the appropriate level of screening is based on the risk of adverse impact to NASA missions. NASA defines three levels of risk for which screening is required (IT-1 has the highest level of risk):
- (i) **IT-1** -- Individuals having privileged access or limited privileged access to systems whose misuse can cause very serious adverse impact to NASA missions. These systems include, for example, those that can transmit commands directly modifying the behavior of spacecraft, satellites or aircraft.
  - (ii) **IT-2** -- Individuals having privileged access or limited privileged access to systems whose misuse can cause serious adverse impact to NASA missions. These systems include, for example, those that can transmit commands directly modifying the behavior of payloads on spacecraft, satellites or aircraft; and those that contain the primary copy of "level 1" data whose cost to replace exceeds one million dollars.
  - (iii) **IT-3** -- Individuals having privileged access or limited privileged access to systems whose misuse can cause significant adverse impact to NASA missions. These systems include, for example, those that interconnect with a NASA network in a way that exceeds access by the general public, such as bypassing firewalls; and systems operated by the contractor for NASA whose function or data has substantial cost to replace, even if these systems are not interconnected with a NASA network.
- (3) Screening for individuals shall employ forms appropriate for the level of risk as follows:
- (i) IT-1: Fingerprint Card (FC) 258 and Standard Form (SF) 85P, Questionnaire for Public Trust Positions;
  - (ii) IT-2: FC 258 and SF 85, Questionnaire for Non-Sensitive Positions; and
  - (iii) IT-3: NASA Form 531, Name Check, and FC 258.
- (4) The Contracting Officer may allow the Contractor to conduct its own screening of individuals requiring privileged access or limited privileged access provided the Contractor can demonstrate that the procedures used by the Contractor are equivalent to NASA's personnel screening procedures. As used here, equivalent includes a check for criminal history, as would be conducted by NASA, and completion of a questionnaire covering the same information as would be required by NASA.

- (5) Screening of contractor personnel may be waived by the Contracting Officer for those individuals who have proof of –
  - (i) Current or recent national security clearances (within last three years);
  - (ii) Screening conducted by NASA within last three years; or
  - (iii) Screening conducted by the Contractor, within last three years, that is equivalent to the NASA personnel screening procedures as approved by the Contracting Officer under paragraph (d )(4) of this clause.
- e) The Contractor shall ensure that its employees, in performance of the contract, receive annual IT security training in NASA IT Security policies, procedures, computer ethics, and best practices in accordance with NPR 2810.1, Section 4.3 requirements. The contractor may use web-based training available from NASA to meet this requirement.
- f) The Contractor shall afford NASA, including the Office of Inspector General, access to the Contractor's and subcontractors' facilities, installations, operations, documentation, databases and personnel used in performance of the contract. Access shall be provided to the extent required to carry out a program of IT inspection, investigation and audit to safeguard against threats and hazards to the integrity, availability and confidentiality of NASA data or to the function of computer systems operated on behalf of NASA, and to preserve evidence of computer crime.
- g) The Contractor shall incorporate the substance of this clause in all subcontracts that meet the conditions in paragraph (a) of this clause.

(End of clause)

**I.5 OMBUDSMAN (NASA 1852.215-84) (OCT 2003) (ALT D) (JUN 2000)**

- (a) An ombudsman has been appointed to hear and facilitate the resolution of concerns from offerors, potential offerors, and contractors during the preaward and postaward phases of this acquisition. When requested, the ombudsman will maintain strict confidentiality as to the source of the concern. The existence of the ombudsman is not to diminish the authority of the contracting officer, the Source Evaluation Board, or the selection official. Further, the ombudsman does not participate in the evaluation of proposals, the source selection process, or the adjudication of formal contract disputes. Therefore, before consulting with an ombudsman, interested parties must first address their concerns, issues, disagreements, and/or recommendations to the contracting officer for resolution.
- (b) If resolution cannot be made by the contracting officer, interested parties may contact the installation ombudsman, Randy K. Gish, Attn: Mail Code AC, 2101 NASA Parkway, Houston, TX 77058, 281-483-0490, facsimile 281-483-2200, email: randy.k.gish@nasa.gov.
- (c) If this is a task or delivery order contract, the ombudsman shall review complaints from contractors and ensure they are afforded a fair opportunity to be considered, consistent with the procedures of the contract.

(End of clause)

**I.6 ORDERING (52.216-18) (OCT 1995)**

- (a) Any supplies and services to be furnished under this contract shall be ordered by issuance of delivery orders or task orders by the individuals or activities designated in the Schedule. Such orders may be issued from *September 8, 2009 through September 7, 2014*.
- (b) All delivery orders or task orders are subject to the terms and conditions of this contract. In the event of conflict between a delivery order or task order and this contract, the contract shall control.
- (c) If mailed, a delivery order or task order is considered "issued" when the Government deposits the order in the mail. Orders may be issued orally, by facsimile, or by electronic commerce methods only if authorized in the Schedule.

(End of clause)

**I.7 ORDER LIMITATIONS (52.216-19) (OCT 1995)**

- (a) Minimum order. When the Government requires supplies or services covered by this contract in an amount of less than **TBD by NASA after final revision of proposal** the Government is not obligated to purchase, nor is the Contractor obligated to furnish, those supplies or services under the contract.
- (b) Maximum order. The Contractor is not obligated to honor-
  - (1) Any order for a single item in excess of **TBD by NASA after final revision of proposal**
  - (2) Any order for a combination of items in excess of **TBD by NASA after final revision of proposal**; or
  - (3) A series of orders from the same ordering office within 5 business days that together call for quantities exceeding the limitation in paragraph (b)(1) or (2) of this section.
- (c) For the purpose of placing a maximum Not-To-Exceed (NTE) amount on this Schedule, the maximum amount of IDIQ supplies and services ordered in total under this contract shall not exceed the maximum NTE amount of **TBD by NASA after final revision of proposal**. This NTE amount includes both cost and fee. The maximum NTE amount is an estimate and does not reflect an obligation of the Government. The Government's obligation hereunder shall be based on that specified in the task/delivery orders issued during the period of the contract.
- (d) The minimum amount of IDIQ supplies and services ordered in total and paid for under this Schedule shall be **TBD by NASA after final revision of proposal**. This amount includes both cost and fee.
- (e) If this is a requirements contract (i.e., includes the Requirements clause at subsection 52.216-21 of the Federal Acquisition Regulation (FAR)), the Government is not required to order a part of

any one requirement from the Contractor if that requirement exceeds the maximum-order limitations in paragraph (b) of this section.

- (f) Notwithstanding paragraphs (b) and (e) of this section, the Contractor shall honor any order exceeding the maximum order limitations in paragraph (b), unless that order (or orders) is returned to the ordering office within 5 business days after issuance, with written notice stating the Contractor's intent not to ship the item (or items) called for and the reasons. Upon receiving this notice, the Government may acquire the supplies or services from another source.

(End of clause)

**I.8 INDEFINITE QUANTITY (52.216-22) (OCT 1995)**

- (a) This is an indefinite-quantity contract for the supplies or services specified, and effective for the period stated, in the Schedule. The quantities of supplies and services specified in the Schedule are estimates only and are not purchased by this contract.
- (b) Delivery or performance shall be made only as authorized by orders issued in accordance with the Ordering clause. The Contractor shall furnish to the Government, when and if ordered, the supplies or services specified in the Schedule up to and including the quantity designated in the Schedule as the "maximum." The Government shall order at least the quantity of supplies or services designated in the Schedule as the "minimum."
- (c) Except for any limitations on quantities in the Order Limitations clause or in the Schedule, there is no limit on the number of orders that may be issued. The Government may issue orders requiring delivery to multiple destinations or performance at multiple locations.
- (d) Any order issued during the effective period of this contract and not completed within that period shall be completed by the Contractor within the time specified in the order. The contract shall govern the Contractor's and Government's rights and obligations with respect to that order to the same extent as if the order were completed during the contract's effective period; provided, that the Contractor shall not be required to make any deliveries beyond 12 months after contract period of performance identified in ordering period identified in I.6 "Ordering".

(End of clause)

**I.9 PAYMENT FOR OVERTIME PREMIUMS (FAR 52.222-2) (JUL 1990)**

- (a) The use of overtime is authorized under this contract if the overtime premium does not exceed \$0 or the overtime premium is paid for work-
- (1) Necessary to cope with emergencies such as those resulting from accidents, natural disasters, breakdowns of production equipment, or occasional production bottlenecks of a sporadic nature;
  - (2) By indirect-labor employees such as those performing duties in connection with administration, protection, transportation, maintenance, standby plant protection, operation of utilities, or accounting;

- (3) To perform tests, industrial processes, laboratory procedures, loading or unloading of transportation conveyances, and operations in flight or afloat that are continuous in nature and cannot reasonably be interrupted or completed otherwise; or
  - (4) That will result in lower overall costs to the Government.
- (b) Any request for estimated overtime premiums that exceeds the amount specified above shall include all estimated overtime for contract completion and shall-
- (1) Identify the work unit; *e.g.*, department or section in which the requested overtime will be used, together with present workload, staffing, and other data of the affected unit sufficient to permit the Contracting Officer to evaluate the necessity for the overtime;
  - (2) Demonstrate the effect that denial of the request will have on the contract delivery or performance schedule;
  - (3) Identify the extent to which approval of overtime would affect the performance or payments in connection with other Government contracts, together with identification of each affected contract; and
  - (4) Provide reasons why the required work cannot be performed by using multishift operations or by employing additional personnel.

(End of clause)

**I.10 RIGHTS IN DATA-GENERAL (FAR 52.227-14) (JUN 1987) as modified by NASA FAR Supplement 1852.227-14, includes 52.227-14 ALT II (JUN 1987) (insertion of (g)(2), ALT III (JUN 1987) (insertion of (g)(3)(i), and ALT V (JUN 1987) (insertion of (i).**

*(a) Definitions.*

"Computer software," as used in this clause, means computer programs, computer data bases, and documentation thereof.

"Data," as used in this clause, means recorded information, regardless of form or the media on which it may be recorded. The term includes technical data and computer software. The term does not include information incidental to contract administration, such as financial, administrative, cost or pricing, or management information.

"Form, fit, and function data," as used in this clause, means data relating to items, components, or processes that are sufficient to enable physical and functional interchangeability, as well as data identifying source, size, configuration, mating, and attachment characteristics, functional characteristics, and performance requirements; except that for computer software it means data identifying source, functional characteristics, and performance requirements but specifically excludes the source code, algorithm, process, formulae, and flow charts of the software.

"Limited rights," as used in this clause, means the rights of the Government in limited rights data as set forth in the Limited Rights Notice of paragraph (g)(2) if included in this clause.

"Limited rights data," as used in this clause, means data (other than computer software) that embody trade secrets or are commercial or financial and confidential or privileged, to the extent that such data pertain to items, components, or processes developed at private expense, including minor modifications thereof.

"Restricted computer software," as used in this clause, means computer software developed at private expense and that is a trade secret; is commercial or financial and is confidential or privileged; or is published copyrighted computer software, including minor modifications of such computer software.

"Restricted rights," as used in this clause, means the rights of the Government in restricted computer software, as set forth in a Restricted Rights Notice of paragraph (g)(3) if included in this clause, or as otherwise may be provided in a collateral agreement incorporated in and made part of this contract, including minor modifications of such computer software.

"Technical data," as used in this clause, means data (other than computer software) which are of a scientific or technical nature.

"Unlimited rights," as used in this clause, means the right of the Government to use, disclose, reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, in any manner and for any purpose, and to have or permit others to do so.

*(b) Allocation of rights.*

(1) Except as provided in paragraph (c) of this clause regarding copyright, the Government shall have unlimited rights in-

- (i) Data first produced in the performance of this contract;
- (ii) Form, fit, and function data delivered under this contract;
- (iii) Data delivered under this contract (except for restricted computer software) that constitute manuals or instructional and training material for installation, operation, or routine maintenance and repair of items, components, or processes delivered or furnished for use under this contract; and
- (iv) All other data delivered under this contract unless provided otherwise for limited rights data or restricted computer software in accordance with paragraph (g) of this clause.

(2) The Contractor shall have the right to-

- (i) Use, release to others, reproduce, distribute, or publish any data first produced or specifically used by the Contractor in the performance of this contract, unless provided otherwise in paragraph (d) of this clause;
- (ii) Protect from unauthorized disclosure and use those data which are limited rights data or restricted computer software to the extent provided in paragraph (g) of this clause;



- (iii) Substantiate use of, add or correct limited rights, restricted rights, or copyright notices and to take other appropriate action, in accordance with paragraphs (e) and (f) of this clause; and
- (iv) Establish claim to copyright subsisting in data first produced in the performance of this contract to the extent provided in paragraph (c)(1) of this clause.

(c) Copyright-

- (1) Data first produced in the performance of this contract. Unless provided otherwise in paragraph (d) of this clause, the Contractor may establish, without prior approval of the Contracting Officer, claim to copyright subsisting in scientific and technical articles based on or containing data first produced in the performance of this contract and published in academic, technical or professional journals, symposia proceedings or similar works. The prior, express written permission of the Contracting Officer is required to establish claim to copyright subsisting in all other data first produced in the performance of this contract. When claim to copyright is made, the Contractor shall affix the applicable copyright notices of 17 U.S.C. 401 or 402 and acknowledgment of Government sponsorship (including contract number) to the data when such data are delivered to the Government, as well as when the data are published or deposited for registration as a published work in the U.S. Copyright Office. For data other than computer software the Contractor grants to the Government, and others acting on its behalf, a paid-up, nonexclusive, irrevocable worldwide license in such copyrighted data to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the Government. For computer software, the Contractor grants to the Government and others acting in its behalf, a paid-up nonexclusive, irrevocable worldwide license in such copyrighted computer software to reproduce, prepare derivative works, and perform publicly and display publicly by or on behalf of the Government.
- (2) Data not first produced in the performance of this contract. The Contractor shall not, without prior written permission of the Contracting Officer, incorporate in data delivered under this contract any data not first produced in the performance of this contract and which contains the copyright notice of 17 U.S.C. 401 or 402, unless the Contractor identifies such data and grants to the Government, or acquires on its behalf, a license of the same scope as set forth in paragraph (c)(1) of this clause; provided, however, that if such data are computer software the Government shall acquire a copyright license as set forth in paragraph (g)(3) of this clause if included in this contract or as otherwise may be provided in a collateral agreement incorporated in or made part of this contract.
- (3) Removal of copyright notices. The Government agrees not to remove any copyright notices placed on data pursuant to this paragraph (c), and to include such notices on all reproductions of the data.

(d) Release, publication and use of data

- (1) The Contractor shall have the right to use, release to others, reproduce, distribute, or publish any data first produced or specifically used by the Contractor in the performance of this contract, except to the extent such data may be subject to the Federal export control or national security

laws or regulations, or unless otherwise provided in this paragraph of this clause or expressly set forth in this contract.

- (2) The Contractor agrees that to the extent it receives or is given access to data necessary for the performance of this contract which contain restrictive markings, the Contractor shall treat the data in accordance with such markings unless otherwise specifically authorized in writing by the Contracting Officer.

(e) Unauthorized marking of data.

- (1) Notwithstanding any other provisions of this contract concerning inspection or acceptance, if any data delivered under this contract are marked with the notices specified in paragraph (g)(2) or (g)(3) of this clause and use of such is not authorized by this clause, or if such data bears any other restrictive or limiting markings not authorized by this contract, the Contracting Officer may at any time either return the data to the Contractor, or cancel or ignore the markings. However, the following procedures shall apply prior to canceling or ignoring the markings.

- (i) The Contracting Officer shall make written inquiry to the Contractor affording the Contractor 30 days from receipt of the inquiry to provide written justification to substantiate the propriety of the markings;

- (ii) If the Contractor fails to respond or fails to provide written justification to substantiate the propriety of the markings within the 30-day period (or a longer time not exceeding 90 days approved in writing by the Contracting Officer for good cause shown), the Government shall have the right to cancel or ignore the markings at any time after said period and the data will no longer be made subject to any disclosure prohibitions.

- (iii) If the Contractor provides written justification to substantiate the propriety of the markings within the period set in subdivision (e)(1)(i) of this clause, the Contracting Officer shall consider such written justification and determine whether or not the markings are to be cancelled or ignored. If the Contracting Officer determines that the markings are authorized, the Contractor shall be so notified in writing. If the Contracting Officer determines, with concurrence of the head of the contracting activity, that the markings are not authorized, the Contracting Officer shall furnish the Contractor a written determination, which determination shall become the final agency decision regarding the appropriateness of the markings unless the Contractor files suit in a court of competent jurisdiction within 90 days of receipt of the Contracting Officer's decision. The Government shall continue to abide by the markings under this subdivision (e)(1)(iii) until final resolution of the matter either by the Contracting Officer's determination becoming final (in which instance the Government shall thereafter have the right to cancel or ignore the markings at any time and the data will no longer be made subject to any disclosure prohibitions), or by final disposition of the matter by court decision if suit is filed.

- (2) The time limits in the procedures set forth in paragraph (e)(1) of this clause may be modified in accordance with agency regulations implementing the Freedom of Information Act (5 U.S.C. 552) if necessary to respond to a request thereunder.

- (3) This paragraph (e) does not apply if this contract is for a major system or for support of a major system by a civilian agency other than NASA and the U.S. Coast Guard agency subject to the provisions of Title III of the Federal Property and Administrative Services Act of 1949.
- (4) Except to the extent the Government's action occurs as the result of final disposition of the matter by a court of competent jurisdiction, the Contractor is not precluded by this paragraph (e) from bringing a claim under the Contract Disputes Act, including pursuant to the Disputes clause of this contract, as applicable, that may arise as the result of the Government removing or ignoring authorized markings on data delivered under this contract.

(f) Omitted or incorrect markings.

- (1) Data delivered to the Government without either the limited rights or restricted rights notice as authorized by paragraph (g) of this clause, or the copyright notice required by paragraph (c) of this clause, shall be deemed to have been furnished with unlimited rights, and the Government assumes no liability for the disclosure, use, or reproduction of such data. However, to the extent the data has not been disclosed without restriction outside the Government, the Contractor may request, within 6 months (or a longer time approved by the Contracting Officer for good cause shown) after delivery of such data, permission to have notices placed on qualifying data at the Contractor's expense, and the Contracting Officer may agree to do so if the Contractor-

- (i) Identifies the data to which the omitted notice is to be applied;

- (ii) Demonstrates that the omission of the notice was inadvertent;

- (iii) Establishes that the use of the proposed notice is authorized; and

- (iv) Acknowledges that the Government has no liability with respect to the disclosure, use, or reproduction of any such data made prior to the addition of the notice or resulting from the omission of the notice.

- (2) The Contracting Officer may also (i) permit correction at the Contractor's expense of incorrect notices if the Contractor identifies the data on which correction of the notice is to be made, and demonstrates that the correct notice is authorized, or (ii) correct any incorrect notices.

(g) Protection of limited rights data and restricted computer software.

- (1) When data other than that listed in subdivisions (b)(1)(i), (ii), and (iii) of this clause are specified to be delivered under this contract and qualify as either limited rights data or restricted computer software, if the Contractor desires to continue protection of such data, the Contractor shall withhold such data and not furnish them to the Government under this contract. As a condition to this withholding, the Contractor shall identify the data being withheld and furnish form, fit, and function data in lieu thereof. Limited rights data that are formatted as a computer data base for delivery to the Government are to be treated as limited rights data and not restricted computer software.

- (2) Notwithstanding paragraph (g)(1) of this clause, the contract may identify and specify the delivery of limited rights data, or the Contracting Officer may require by written request the delivery of limited rights data that has been withheld or would otherwise be withholdable. If delivery of such data is so required, the Contractor may affix the following "Limited Rights Notice" to the data and the Government will thereafter treat the data, subject to the provisions of paragraphs (e) and (f) of this clause, in accordance with such Notice:

**Limited Rights Notice (June 1987)**

- (a) These data are submitted with limited rights under Government Contract No. (and subcontract, if appropriate). These data may be reproduced and used by the Government with the express limitation that they will not, without written permission of the Contractor, be used for purposes of manufacture nor disclosed outside the Government; except that the Government may disclose these data outside the Government for the following purposes, if any; provided that the Government makes such disclosure subject to prohibition against further use and disclosure:
- (1) Use (except for manufacture) by support service Contractors.
  - (2) Evaluation by nongovernment evaluators.
  - (3) Use (except for manufacture) by other Contractors participating in the Government's program of which the specific contract is a part, for information and use in connection with the work performed under each contract.
  - (4) Emergency repair or overhaul work.
  - (5) Release to a foreign government, or instrumentality thereof, as the interests of the United States Government may require, for information or evaluation, or for emergency repair or overhaul work by such government.
- (b) This Notice shall be marked on any reproduction of these data, in whole or in part.

**(End of notice)**

- (3) (i) Notwithstanding paragraph (g)(1) of this clause, the contract may identify and specify the delivery of restricted computer software, or the Contracting Officer may require by written request the delivery of restricted computer software that has been withheld or would otherwise be withholdable. If delivery of such computer software is so required, the Contractor may affix the following "Restricted Rights Notice" to the computer software and the Government will thereafter treat the computer software, subject to paragraphs (e) and (f) of this clause, in accordance with the Notice:

**Restricted Rights Notice (June 1987)**

- (a) This computer software is submitted with restricted rights under Government Contract No. \_\_\_\_\_ (and subcontract, if appropriate). It may not be used, reproduced, or disclosed by

the Government except as provided in paragraph (b) of this Notice or as otherwise expressly stated in the contract.

(b) This computer software may be-

- (1) Used or copied for use in or with the computer or computers for which it was acquired, including use at any Government installation to which such computer or computers may be transferred;
  - (2) Used or copied for use in a backup computer if any computer for which it was acquired is inoperative;
  - (3) Reproduced for safekeeping (archives) or backup purposes;
  - (4) Modified, adapted, or combined with other computer software, provided that the modified, combined, or adapted portions of the derivative software incorporating restricted computer software are made subject to the same restricted rights;
  - (5) Disclosed to and reproduced for use by support service Contractors in accordance with paragraphs (b)(1) through (4) of this clause, provided the Government makes such disclosure or reproduction subject to these restricted rights; and
  - (6) Used or copied for use in or transferred to a replacement computer.
- (c) Notwithstanding the foregoing, if this computer software is published copyrighted computer software, it is licensed to the Government, without disclosure prohibitions, with the minimum rights set forth in paragraph (b) of this clause.
- (d) Any other rights or limitations regarding the use, duplication, or disclosure of this computer software are to be expressly stated in, or incorporated in, the contract.
- (e) This Notice shall be marked on any reproduction of this computer software, in whole or in part.

**(End of notice)**

- (ii) Where it is impractical to include the Restricted Rights Notice on restricted computer software, the following short-form Notice may be used in lieu thereof:

**Restricted Rights Notice Short Form (June 1987)**

Use, reproduction, or disclosure is subject to restrictions set forth in Contract No. (and subcontract, if appropriate) with (name of Contractor and subcontractor).

**(End of notice)**

- (iii) If restricted computer software is delivered with the copyright notice of 17 U.S.C. 401, it will be presumed to be published copyrighted computer software licensed to the Government without disclosure prohibitions, with the minimum rights set forth in paragraph (b) of this clause, unless the Contractor includes the following statement with such copyright notice: "Unpublished-rights reserved under the Copyright Laws of the United States."
- (h) Subcontracting. The Contractor has the responsibility to obtain from its subcontractors all data and rights therein necessary to fulfill the Contractor's obligations to the Government under this contract. If a subcontractor refuses to accept terms affording the Government such rights, the Contractor shall promptly bring such refusal to the attention of the Contracting Officer and not proceed with subcontract award without further authorization.
- (i) Relationship to patents. Nothing contained in this clause shall imply a license to the Government under any patent or be construed as affecting the scope of any license or other right otherwise granted to the Government.
- (j) The Contractor agrees, except as may be otherwise specified in this contract for specific data items listed as not subject to this paragraph, that the Contracting Officer or an authorized representative may, up to three years after acceptance of all items to be delivered under this contract, inspect at the Contractor's facility any data withheld pursuant to paragraph (g)(1) of this clause, for purposes of verifying the Contractor's assertion pertaining to the limited rights or restricted rights status of the data or for evaluating work performance. Where the Contractor whose data are to be inspected demonstrates to the Contracting Officer that there would be a possible conflict of interest if the inspection were made by a particular representative, the Contracting Officer shall designate an alternate inspector.

(End of clause)

**I.11 RIGHTS TO PROPOSAL DATA (TECHNICAL) (FAR 52.227-23) (JUN 1987)**

Except for data contained in Volumes I through VII, including any Addendums, Amendments or Revisions thereto that are marked with the legend "LOCKHEED MARTIN PROPRIETARY INFORMATION", it is agreed that as a condition of award of this contract, and notwithstanding the conditions of any notice appearing thereon, the Government shall have unlimited rights (as defined in the "Rights in Data-General" clause contained in this contract) in and to the technical data contained in the proposal dated 20 March 2006, 20 April 2006, 21 July 2006 and 28 July 2006 upon which this contract is based.

(End of clause)

**I.12 EARNED VALUE MANAGEMENT SYSTEM (MAR 1999) (Deviation)**

- (a) In the performance of this contract, the Contractor shall use an earned value management system (EVMS) that has been recognized by the cognizant Administrative Contracting Officer (ACO) as complying with the guidelines specified in ANSI/EIA Standard 748, Industry Guidelines for Earned Value Management Systems.

- (b) If, at the time of award, the Contractor's EVMS has not been recognized by the ACO as complying with the EVMS guidelines, the Contractor shall apply the system to the contract and shall take timely action to implement its plan to obtain compliance. The Contractor shall follow and implement the approved compliance plan in a timely fashion. The Government will conduct a Compliance Review to assess the contractor's compliance with its plan, and if the Contractor does not follow the approved implementation schedule or correct all resulting system deficiencies identified as a result of the compliance review within a reasonable time, the Contracting Officer may take remedial action, that may include, but is not limited to, a reduction in fee.
- (c) The Government will require integrated baseline reviews. Such reviews shall be scheduled as early as practicable and should be conducted within 180 calendar days after contract award or exercise of significant contract options; or within two months after distribution of a supplemental agreement that implemented a significant funding realignment or effected a significant change in contract requirements. The objective of IBRs is for the Government and the Contractor to jointly assess the Contractor's baseline to be used for performance measurement to ensure complete coverage of the statement of work, logical scheduling of the work activities, adequate resourcing, and identification of inherent risks.
- (d) Unless a waiver is granted by the ACO, Contractor proposed EVMS changes require approval of the ACO prior to implementation. The ACO shall advise the Contractor of the acceptability of such changes within 30 calendar days after receipt of the notice of proposed changes from the Contractor. If the advance approval requirements are waived by the ACO, the Contractor shall disclose EVMS changes to the ACO and provide an information copy to the NASA Contracting Officer at least 14 calendar days prior to the effective date of implementation.
- (e) The Contractor agrees to provide access to all pertinent records and data requested by the ACO or a duly authorized representative. Access is to permit Government surveillance to ensure that the EVMS complies, and continues to comply, with the criteria referenced in paragraph (a) of this clause.
- (f) The Contractor shall be responsible for ensuring that the subcontractors identified below to comply with the EVMS requirements at the specified level. If the subcontractor does not have an EVMS that has been recognized by the ACO as compliant with ANSI/EIA 748, the prime contractor shall conduct Compliance Reviews of subcontractors' EVMS in the same manner as described at paragraph (b) of this clause. (Insert list of applicable subcontractors and the level of compliance (i.e., guidelines or principles).)
- (g) If the contractor identifies a need to deviate from the agreed baseline by working against an Over Target Baseline or Over Target Schedule, the contractor shall submit to the Contracting Officer a request for approval to begin implementation of an Over Target Baseline or Over Target Schedule. This request shall include a top-level projection of cost and/or schedule growth, whether or not performance variances will be retained, and a schedule of implementation for the rebaselining. The Government will authorize or deny the request within 30 calendar days after receipt of the request. Failure of the Government to respond within this 30-day period constitutes approval of the request. For cost-reimbursement contracts, the contract budget

baseline shall exclude changes for cost growth increases, other than for authorized changes to the contract requirements.

(End of clause)

**I.13 ENGINEERING CHANGE PROPOSALS (NASA 1852.243-70) (OCT 2001)**

(a) Definitions.

"ECP" means an Engineering Change Proposal (ECP), which is a proposed engineering change and the documentation by which the change is described, justified, and submitted to the procuring activity for approval or disapproval.

(b) Either party to the contract may originate ECPs. Implementation of an approved ECP may occur by either a supplemental agreement or, if appropriate, as a written change order to the contract.

(c) Any ECP submitted to the Contracting Officer shall include a "not-to-exceed" price increase or decrease adjustment amount, if any, and the required time of delivery adjustment, if any, acceptable to the originator of the ECP. If the change is originated within the Government, the Contracting Officer shall obtain a written agreement with the Contractor regarding the "not-to-exceed" price and time of delivery adjustments, if any, prior to issuing an order for implementation of the change.

(d) After submission of a Contractor initiated ECP, the contracting officer may require the Contractor to submit the following information:

- (1) Cost or pricing data in accordance with FAR 15.403-5 if the proposed change meets the criteria for its submission under FAR 15.403-4; or
- (2) Information other than cost or pricing data adequate for contracting officer determination of price reasonableness or cost realism. The contracting officer reserves the right to request additional information if that provided by the Contractor is considered inadequate for that purpose. If the Contractor claims applicability of one of the exceptions to submission of cost or pricing data, it shall cite the exception and provide rationale for its applicability.

(e) If the ECP is initiated by NASA, the contracting officer shall specify the cost information requirements, if any.

**ALT II (SEP 1990)**

An ECP accepted in accordance with the Changes clause of this contract shall not be considered an authorization to the Contractor to exceed the estimated cost in the contract Schedule, unless the estimated cost is increased by the change order or other contract modification.

(End of clause)

**I.14 SUBMISSION OF COMMERCIAL TRANSPORTATION BILLS TO THE GENERAL SERVICES ADMINISTRATION FOR AUDIT (FAR 52.247-67) (JUN 1997)**

(a)(1) In accordance with paragraph (a)(2) of this clause, the Contractor shall submit to the General Services Administration (GSA) for audit, legible copies of all paid freight bills/invoices,



commercial bills of lading (CBL's), passenger coupons, and other supporting documents for transportation services on which the United States will assume freight charges that were paid-

- (i) By the Contractor under a cost-reimbursement contract; and
  - (ii) By a first-tier subcontractor under a cost-reimbursement subcontract hereunder.
- (2) Cost-reimbursement Contractors shall only submit for audit those CBL's with freight shipment charges exceeding \$50.00. Bills under \$50.00 shall be retained on-site by the Contractor and made available for GSA on-site audits. This exception only applies to freight shipment bills and is not intended to apply to bills and invoices for any other transportation services.
- (b) The Contractor shall forward copies of paid freight bills/invoices, CBL's, passenger coupons, and supporting documents as soon as possible following the end of the month, in one package to the:
- General Services Administration  
Attn: FWA  
1800 F. Street, NW  
Washington, DC 20405
- The Contractor shall include the paid freight bills/invoices, CBL's, passenger coupons, and supporting documents for first-tier subcontractors under a cost-reimbursement contract. If the inclusion of the paid freight bills/invoices, CBL's, passenger coupons, and supporting documents for any subcontractor in the shipment is not practicable, the documents may be forwarded to GSA in a separate package.
- (c) Any original transportation bills or other documents requested by GSA shall be forwarded promptly by the Contractor to GSA. The Contractor shall ensure that the name of the contracting agency is stamped or written on the face of the bill before sending it to GSA.
- (d) A statement prepared in duplicate by the Contractor shall accompany each shipment of transportation documents. GSA will acknowledge receipt of the shipment by signing and returning the copy of the statement. The statement shall show-
- (1) The name and address of the Contractor;
  - (2) The contract number including any alpha-numeric prefix identifying the contracting office;
  - (3) The name and address of the contracting office;
  - (4) The total number of bills submitted with the statement; and
  - (5) A listing of the respective amounts paid or, in lieu of such listing, an adding machine tape of the amounts paid showing the Contractor's voucher or check numbers.

(End of clause)

**I.15 CLAUSES INCORPORATED BY REFERENCE (FAR 52.252-2) (FEB 1998)**

This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. Also, the full text of a clause may be accessed electronically at these addresses:

<http://www.arnet.gov/far/>

<http://www.hq.nasa.gov/office/procurement/regs/nfstoc.htm>

(End of clause)

**I.16 AUTHORIZED DEVIATIONS IN CLAUSES (FAR 52.252-6) (APR 1984)**

- (a) The use in this solicitation or contract of any Federal Acquisition Regulation (48 CFR Chapter 1) clause with an authorized deviation is indicated by the addition of "(DEVIATION)" after the date of the clause.
- (b) The use in this solicitation or contract of any NASA (48 CFR Chapter 18) clause with an authorized deviation is indicated by the addition of "(DEVIATION)" after the name of the regulation.

(End of clause)  
(END OF SECTION)

## **ATTACHMENT J-22**

### **APPROACH SPECIFIC REQUIREMENTS**

**For information only – The Approach Specific Requirements  
have been incorporated into Contract Attachment J-1,  
Statement of Work**

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-080
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/5/2005
5. **PAGE:** 1
6. **TITLE:** CEV Wiring Database and Reports
7. **DESCRIPTION/USE:**  
The CEV Wiring Database stores information defining the electrical and optical data, command, and power connectivity in the CEV System, and enables the export and distribution of this information in support of CEV design, integration, testing, certification and documentation activities. NASA will utilize the CEV Wiring Database and Reports to ensure that the contractor's plan for collecting, storing, controlling, implementing and reporting wire harness data is acceptable for the accomplishment of CEV Project objectives.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
None.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.13.
13. **DATA PREPARATION INFORMATION:**
- 13.1. **SCOPE:**  
The CEV Wiring Database is a key component in the implementation of the CEV Wiring Plan. The design of the CEV Wiring Database must provide for the storage, update, retrieval, querying, tracking, reporting and exporting of key wiring information for the CEV System as well as its electrical and optical interfaces with other Constellation elements and external equipment. The CEV Wiring Database will be the primary source of information for the fabrication, installation and verification of the electrical and optical connections for the spacecraft.
- 13.2. **APPLICABLE DOCUMENTS:**
- 13.3. **CONTENTS:**  
The CEV Wiring Database and Reports shall include the following provisions:
  - a) Security provisions to limit access and change authority to designated personnel
  - b) User interface to support the storage, update, retrieval, querying, tracking, reporting and exporting of key wiring-related information as defined by the contractor in the development of the CEV Wiring Plan.
  - c) Fields for the storage of functional and signal path connectivity for the Wiring Subsystem including signal type, signal description, connector designation, signal designation and definition of signal end points by component, connector and pin.
  - d) Fields for the storage of wire harness manufacturing data including wire/cable type, wire/ cable length, terminations of conductors and shields, parts/materials information, and special manufacturing instructions.

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- e) Linkage between the CEV Wiring Database and the CEV Data and Command Dictionary to support integration of CEV Wiring Database signal paths with software channelization and command data.
- f) Ability to export signal path diagrams in standard drawing formats and in PDF.
- g) Ability to export manufacturing drawings and instructions in PDF.
- h) Ability to produce harness status reports describing the current progress of CEV harness definition, fabrication, installation and verification for electrical and optical connectivity including comparisons with an historical metrics record.
- i) Ability to produce connectivity reports and user-defined reports to support the design, test, troubleshooting and operation of the CEV System.
- j) Ability to produce status reports describing the progress of CEV harness drawing definition, release and modification including comparisons with an historical metrics record.
- k) Ability to produce connector configuration reports that support verification of required connector mate/demate status for powered testing.
- l) Ability to produce harness verification documentation to support manual pin-to-pin continuity checks.
- m) Linkage with an automated harness testing system to generate the automated harness testing programs, test adapter cables and test instructions using the information stored in the wiring database.

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1, native database format defined by the Contractor with the ability to export the entire contents of the database in an industry standard database exchange format. Ability to export drawings in standard drawing formats and in PDF. Ability to produce manufacturing instructions in PDF. Ability to produce connectivity reports in Microsoft Excel-compatible format. Ability to produce status reports in Microsoft Word-compatible format.

13.5 **MAINTENANCE:** Contractor-proposed changes to the database structure or reporting capabilities shall be submitted to NASA for approval. Complete re-issue of this document is required with changes clearly identified.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

- 1     **PROGRAM:** CEV
- 2     **DRD NO.:** CEV-T-081
- 3     **DATA TYPE:** 3
- 4     **DATE REVISED:** 12/20/2005
- 5     **PAGE:** 1
- 6     **TITLE:** Launch Abort System Design and Data Book
- 7     **DESCRIPTION/USE:**  
This DRD documents the abort system design information. The comprehensive documentation will provide detailed reference information to support Engineering and Operations throughout the life of the CEV.
- 8     **DISTRIBUTION:** As determined by the Contracting Officer.
- 9     **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10    **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11    **REMARKS:**
- 12    **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6 2.14.  
Related DRD(s): CEV-T-071
- 13    **DATA PREPARATION INFORMATION:**
- 13.1   **SCOPE:**  
The Launch Abort System Design and Databook documents the design and development of the CEV launch abort system. The content of this deliverable addresses the CEV launch abort system in potential usage during launch and first stage launch vehicle ascent operations. (Note: Any launch abort system inherent to the launch vehicle upper stage [if required], based on use of the service module, shall meet and address the requirements specified in CEV DRD-T-071, Propulsion System Design and Databook.)
- 13.2   **APPLICABLE DOCUMENTS:**
- 13.3   **CONTENTS:**  
As a minimum, the deliverable shall include, the following data. All specified design data shall be provided considering nominal, off nominal, and failure operations conditions. Additionally, fluids related subsystems and components shall meet and address the requirements and applicable documents specified in DRD CEV-T-071, Propulsion System Design and Data Book, as part of this DRD deliverable.
  1. Assumptions and groundrules
  2. Subsystem Definition including GFE vs. contractor-supplied assumptions
  3. Subsystem Requirements Analyses
    - (a) Functional decomposition
    - (b) Functional, performance and interface requirements
    - (c) Derived requirements on other systems with analysis that yields the requirements
    - (d) Trade study results
    - (e) Analysis to show the subsystem meets the requirements
  4. Detailed Design Description
    - (a) Hardware element descriptions including data needed to completely understand the operation of the abort system and design rationale
    - (b) Hardware math models and simulation tools description, source algorithms/code and validation report, including benchmarks of test

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results against model predictions.

- (c) Mass, volume, and moments of inertia properties
- (d) Material and component selections, rationale, and compatibility analysis (including vendor component drawings and cross-sections, material usage list, any test reports, mill reports, NDE reports, burst article or qualification test reports that may be available)
- (e) Power and thermal profiles
- (f) Schematic, layouts, drawings and 3-D solid geometric representations of components,
- (g) Interfaces (internal and external hardware and functional interfaces including mechanical, electrical and thermal interfaces, software interfaces, and human interfaces; includes necessary Interface Control Documents)
- (h) Consumables list
- (i) Data bandwidths (data rates); Telemetry; Instrumentation
- (j) Manufacturing concept for hardware (location, type of manufacturing processes, quality control, lot control, etc.)

5. Operational Analyses and Data

- (a) Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight
  - (b) Performance and Margin analyses (including component-level structural stress analysis process and assumptions, safety factors, derating factors, safety margins and rationale, and Margins of Safety tracking)
  - (c) Thermal, static and dynamic (including startup transient, vibro-acoustic) load models and performance calculation models (include model assumptions, model technique, input and output data)
  - (d) Operating environments (natural and induced) and constraints including G-load profiles (both translational and rotational during abort/escape operation and at touch down), and peak surface temperatures, sea states, explosion debris field, including landing footprint debris field, overpressure, and fire ball, etc.
  - (e) Separation dynamics and aerodynamics, multi-vehicle relative motion trajectories, jet interaction induced over pressures (if appropriate), attitude control and disposal performance, and re-contact assessment.
- Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures
- (f) Failure modes
  - (g) Fault Detection, Isolation and Recovery
  - (h) Flight, ground, and test anomaly tracking and disposition process including sibling anomaly tracking process
  - (i) Initialization procedures and parameters
  - (j) Day of launch parameters and late-load requirements
  - (k) Abort analysis
  - (l) Launch scrub turnaround plan

6. Maintainability and testing data

- (a) Test requirements including information on Special Test Equipment design, operations and maintenance.
- (b) Development test concept and rationale, planned activities and test plan
- (c) Concept for hardware integration, assembly, test and checkout
- (d) Maintainability strategies including sparing provisions, shelf-life, and long-term storage provisions,
- (e) Deliverable end item or equipment identification (part number)
- (f) Reliability analysis and assessment, including assumptions and process for verifying reliability
- (g) Component reusability/refurbishment analysis including fluid compatibility and cleanliness needs
- (h) Firing test results, including test configuration and objectives, specific hardware used, test trajectory and sequence of events, comparison of pre-test predicted performance versus actual results, test anomalies, and test conclusions.

7. References and Indication of any changes from the previous submission.

- 13 4 FORMAI: Electronic format per Section J-2 2.3.2 1.
- 13 5 MAINTENANCE: Changes shall be identified and complete re-issue of the document is required.



**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-082
3. **DATA TYPE:** 1
4. **DATE REVISED:** 12/6/2005
5. **PAGE:** 1
6. **TITLE:** Spacecraft Test & Verification Facility System Requirements Document
7. **DESCRIPTION/USE:**  
Define requirements for all Contractor-provided test and verification facilities, facility systems, support equipment, and associated software needed to support module and spacecraft-level qualification, certification, and acceptance test activities.
8. **DISTRIBUTION:** Per Contracting Officer's letter
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.4.  
Related DRD(s): CEV-T-083, CEV-T-084, CEV-T-085
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
Provide requirements for all Contractor-provided test and verification facilities, facility systems, support equipment, and associated software needed to support module and spacecraft-level qualification, certification, and acceptance test activities.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The Spacecraft Test & Verification Facility Requirement Document shall contain the following:
  - a. Narrative description of the purpose and function of the facility, room, and systems.
  - b. Hazard identification requirements (e.g. classification of hazards, type of propellants, types of vents, types of purges, maximum fuel/oxidizer propellant quantities, types of ordinance, power voltages and frequencies, noise levels, RF radiation levels).
  - c. Environmental requirements (e.g. temperature, humidity, particle counts, radio frequency shielding, noise attenuation, etc.).
  - d. Environmental pollution controls.
  - e. Power, grounding and lighting requirements, including the use of uninterruptible power systems and supplies for ground operations activities.
  - f. Backup power and other backup or contingency requirements (chilled water, hot water, data, etc.).
  - g. Plumbing/venting and commodities requirements for test operations activities.
  - h. Fire and hazard protection requirements.
  - i. Communications and data networking systems requirements (e.g., required connections to other test and operations facilities needed).
  - j. Special structural needs requirements (e.g. vibration controls, floor

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loading, etc.).

k. Security requirements (e.g. facilities, facility systems, personnel, hardware, software, data, badging, and access control).

l. Material handling requirements (e.g. crane or hoist requirements).

m. Consideration of human engineering requirements.

n. Configuration management requirements.

o. Scheduling requirements.

p. Functional capabilities requirements.

q. Facility, facility systems, and support equipment certification requirements.

r. Operations requirements, including number and type of personnel required to operate facility.

s. Maintenance requirements.

t. Sustaining engineering and obsolescence planning requirements.

Each document shall contain a section titled 'Verification'. For each requirement in the documents, there shall be a corresponding verification requirement. The document shall contain, in addition to the verification requirements, a verification traceability matrix that establishes the relationship between each System requirement and its verification requirements, and contains the methods that will be used to accomplish the indicated verification actions.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-083
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/6/2005
5. **PAGE:** 1
6. **TITLE:** Spacecraft Test & Verification Facility System Design Document
7. **DESCRIPTION/USE:**  
To document the design for all Contractor-provided test and verification facilities, facility systems, support equipment, and associated software needed to support module and spacecraft-level integration, qualification, certification, and acceptance test activities. To provide visibility into the design of these facilities/systems and to provide detailed reference information to support test and verification operations throughout the life of the CEV.
8. **DISTRIBUTION:** Per Contracting Officer's letter
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.4.  
Related DRD(s): CEV-T-082, CEV-T-084, CEV-T-085
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
For each Spacecraft Test and Verification Facility, provide a top-down hierarchical design from overall facility architecture down to detailed design of hardware and software components and interfaces.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The Spacecraft Test & Verification Facility System Design Document shall contain the following for each facility:
  - a. Description of the purpose, function and concept of operations for the facility.
  - b. Physical layout and dimensions of the facility and system.
  - c. System level architecture of the facility and systems identifying all major hardware and software systems/components and their interfaces.
  - d. Detailed design of all test support hardware components (e.g., test control, simulation generation, data recording/archival, interfaces to the system under test, etc.) down to the card, channel and pin level and including engineering drawings, ICD's and cable routing/network diagrams.
  - e. Detailed design of all test support software components (e.g., test control, simulations, etc.) including software architecture, interfaces and CSCI decomposition.
  - f. Identification of COTS, MOTS and proprietary systems utilized.
  - g. Hazard identification (e.g. classification of hazards, power voltages and frequencies, noise levels, RF radiation levels, actuators, etc.) and detailed design of hazard protection mechanisms.
  - h. Environmental operational constraints (e.g. temperature, humidity, particle counts, radio frequency shielding, noise attenuation, etc.).
  - i. Detailed design of all facility infrastructure systems (e.g., power,

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grounding, cooling, air-conditioning, lighting, etc.).

j. Detailed design of internal and external communications and data networking systems (e.g., intercomm systems, video systems, connections to other test and operations facilities, etc.).

k. Special structural considerations (e.g. vibration controls, floor loading, etc.).

l. Detailed design of security systems (e.g. facilities, facility systems, personnel, hardware, software, data, badging, and access control).

m. Special equipment utilized (crane, hoist, etc.).

n. Maintenance, operations and configuration management strategies and plans.

134 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

135 **MAINTENANCE:** Changes shall be incorporated by complete reissue.

1. **PROGRAM:** CEV 2. **DRD NO.:** CEV-T-084  
3. **DATA TYPE:** 2 4. **DATE REVISED:** 12/21/2005  
5. **PAGE:** 1  
6. **TITLE:** Spacecraft Test & Verification Facility Certification Plan  
7. **DESCRIPTION/USE:**  
Provides the Contractor's plan(s) for certifying all Contractor-provided test and verification facilities, facility systems, support equipment, and associated software needed to support module and spacecraft-level qualification, certification, and acceptance test activities.  
8. **DISTRIBUTION:** Per Contracting Officer's letter  
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix  
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix  
11. **REMARKS:**  
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.4.  
Related DRD(s): CEV-T-082, CEV-T-083, CEV-T-085  
13. **DATA PREPARATION INFORMATION:**  
13.1 **SCOPE:**  
The Test & Verification Facility Certification Plan(s) provides the Contractor's plan for certifying all Contractor-provided test and verification facilities, facility systems, support equipment, and associated software needed to support module and spacecraft-level qualification, certification, and acceptance test activities. This certification shall meet all requirements in CEV-T-082, Spacecraft Test & Verification Facility System Requirements Document.  
13.2 **APPLICABLE DOCUMENTS:**  
13.3 **CONTENTS:**  
The certification testing plan shall address:  
a. Certification method (test, analysis, simulation, inspection)  
b. Testing requirements  
c. Test configurations  
d. Test conditions  
e. Test methods  
f. Test schedules  
g. Data recording methods  
h. Required test equipment and software  
i. Requirements traceability to shalls in CEV-T-082, Spacecraft Test & Verification Facility System Requirements Document  
13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.  
13.5 **MAINTENANCE:** Changes shall be incorporated by complete reissue.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-085
3. **DATA TYPE:** 1
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Spacecraft Test & Verification Facility Certification Package
7. **DESCRIPTION/USE:**  
To provide the evidence and audit trail required by NASA to verify that the results from the facility verification activities indicate that all requirements were met.
8. **DISTRIBUTION:** Per Contracting Officer's letter
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
The Contractor shall provide certification results for all Contractor-provided test and verification facilities, facility systems, support equipment and associated software needed to support module and spacecraft-level qualification, certification, and acceptance test activities.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.4.  
Related DRD(s): CEV-T-082, CEV-T-083, CEV-T-084
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Spacecraft Test & Verification Facility Certification Package contains the elements of documentation required to establish that all requirements have been met by facilities, facility systems, support equipment and associated software.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The Spacecraft Test & Verification Facility Certification Package shall contain the following:
  1. Current version of the Spacecraft Test & Verification Facility Requirement Document for the facilities, facility systems, support equipment and associated software that is being certified
  2. Current version of the Spacecraft Test & Verification Facility Certification Plan for the facilities, facility systems, support equipment and associated software that is being certified, including the verification matrix
  3. Verification compliance report, including the verification matrix mapped to all verification data. This report shall include:
    - a) Test report
    - b) List of approved operational controls
    - c) Structural integrity verification
    - d) Materials information
    - e) Electrical information
    - f) Electromagnetic compatibility information
    - g) Temperature validation information
    - h) Structural validation information

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- i) Pressure systems information
  - j) Performance verification information
  - k) Verification tracking log
  - l) Inspections reports
  - m) Demonstrations reports
  - 4. Risk information obtained from the FMEA and hazard analysis
  - 5. Waivers, deviations and non-conformance reports
  - 6. Discrepancy reports and problem closure reports relevant to certification
  - 7. Limited life items list
  - 8. Engineering drawings
  - 9. Software Version Description Document (VDD)
- 134 **FORMAT**: Electronic format per Section J-2 2.3.2.1.
- 135 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-086
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Manufacturing and Assembly Plan
7. **DESCRIPTION/USE:**  
This document provides the plans for manufacturing and assembling the flight articles, associated unique tooling, fixtures, support and test equipment for producing an integrated, tested CEV.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.5.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Manufacturing and Assembly Plan applies to all hardware designed, built and assembled to create and support the development of the CEV System throughout the life time of the program.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The Manufacturing and Assembly Plan shall address hardware development of (category):
  - 1) Test articles
  - 2) Prototype vehicles
  - 3) Flight vehicles
  - 4) Ground Support Equipment (GSE)
  - 5) Flight Support Equipment (FSE)
  - 6) Test Support Equipment (TSE)
  - 7) Maintenance Support Equipment (MSE)

This Manufacturing and Assembly Plan shall include the following specialty areas:

  - 1) vehicle primary structure
  - 2) secondary structure to attach subsystem components (as required) to the primary structure
  - 3) subsystem hardware interfaces to the Spacecraft (cabling, power, fluid systems, attachment hardware)
  - 4) lifting fixtures and attachment hardware (for all required orientations/configurations), with considerations for both launch and landing sites
  - 5) transportation/holding apparatuses (for all pieces), with considerations for both launch and landing sites
  - 6) test fixtures (for all test verification orientations)
  - 7) flight interface mechanical simulators for ISS and the launch vehicle.

The Manufacturing and Assembly Plan shall list information for the design



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process, including:

- 1) loads data (by category)
- 2) preferred standard hardware list
- 3) preferred standard manufacturing processes
- 4) soft vs. hard tooling
- 5) design for manufacturability

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required

1 PROGRAM: CEV 2 DRD NO.: CEV-T-087  
3 DATA TYPE: 2 4 DATE REVISED: 12/5/2005  
5 PAGE: 1  
6 TITLE: CEV Handling and Transportation Plan  
7 DESCRIPTION/USE:  
This document provides the plans for handling and transporting the CEV spacecraft, modules, and components. This document includes the plans and stipulations (how, what and when) for all CEV shipping containers, test fixtures, and transportation equipment.  
8 DISTRIBUTION: As determined by the Contracting Officer.  
9 INITIAL SUBMISSION: Per Data Requirements Matrix  
10 SUBMISSION FREQUENCY: Per Data Requirements Matrix  
11 REMARKS:  
12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 6.5.  
Related DRD(s): CEV-O-008  
13 DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
This DRD covers ground movement of the CEV (whether in pieces or whole) from initial assembly through testing, final assembly, and checkout of the CEV at the launch site to post-flight recovery and processing.  
13.2 APPLICABLE DOCUMENTS:  
13.3 CONTENTS:  
This DRD shall document handling and transportation plans required for the CEV development, tests and flights. These plans shall include details for the following activities:  
1) assembling, testing, and delivery of CEV prototypes, test only hardware, lifting fixtures and attachment hardware (for all required orientations/configurations), transportation/holding apparatuses for all CEV pieces, test fixtures (for all orientations/configurations), and flight interface mechanical simulators (ISS & launch vehicle) to test, integration, and launch processing facilities  
2) assembling the CEV pieces (primary structure, secondary structure, subsystem components, and attach hardware)  
3) testing the CEV in required orientations and configurations as required in the Master Verification Plan  
4) delivering the CEV to the launch site either in pieces (assembling the CEV at the launch site) or fully assembled to processing facilities or the launch site (shipping containers and transportation)  
5) supporting the integration of the CEV flight system to the launch vehicle and ground systems  
6) supporting the delivery of lifting fixtures and attachment hardware (for all required orientations/configurations) and transportation/holding apparatuses for all CEV pieces to the landing site  
7) supporting delivery (shipping containers and transportation) of the CEV from the landing site to the launch site

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8) development of re-usable shipping containers for shipment of CEV components

134 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

135 **MAINTENANCE:** Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-088
3. **DATA TYPE:** 2/3\*
4. **DATE REVISED:** 12/20/2005
5. **PAGE:** 1
6. **TITLE:** CEV Imagery Plan/Imagery Deliverables
7. **DESCRIPTION/USE:**  
To define the approach and strategy for the imagery documentation (still photo, motion picture, digital imagery, or video) of the configuration of the CEV spacecraft, systems, subsystems and components during manufacture, bench testing, assembly, integration, and closeout. The imagery will be used to support on-orbit maintenance, configuration verification, post launch evaluation, anomaly analysis, sustaining engineering, and hardware reconfiguration.
8. **DISTRIBUTION:** Per Contracting Officer's letter
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
Imagery Plan will be Type 2. Imagery will be Type 3.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.5.  
Related DRD(s): CEV-T-014
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The CEV Imagery Plan shall define the approach and strategy for documenting of the CEV spacecraft and its components during manufacturing, test, ground operations, ascent and on-orbit phases, re-entry and descent phases, and landing and recovery phases, including crew egress.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The CEV Imagery Plan shall include:
  1. The approach and strategy for imagery documentation of the CEV spacecraft and its systems, subsystems and components during manufacture, assembly, and test. The plan shall include the approach for imaging the following areas:
    - (a) Intravehicular Activity (IVA) Hardware
      - i. Orbital Replacement Units (ORUs) as-installed to show visible connectors, fittings, attachment fasteners, reference designators, thermal cooling interfaces, and filters.
      - ii. M/assembly interfaces of ORU and other organizational maintenance hardware.
      - iii. Fluid/gas lines and electrical/data harnesses prior to final mate.
      - iv. Fluid/gas lines and electrical/data harnesses as installed to show visible fittings, couplings, connectors, and reference designators.
      - v. Each area to show ORUs and other systems hardware accessibility and the final configuration of the hardware just prior to close-out panel installation.
      - vi. Close-out panels and covers to show attachment fasteners and

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- nomenclature (labels, placards, etc.)
- vii. Overall and close-up views of ORUs and system hardware.
- viii. Manual crew interfaces - e.g., panels, hatches, valves, etc
- (b) Extravehicular Activity (EVA) Hardware
  - i. Performance of a photo survey of everything within the physical reach along the primary and secondary EVA translation paths on the spacecraft. This is defined as a 1.1-meter cylinder tangent to the handrail and the hull. The EVA handholds themselves are a key photo target. Also required are several views of any item that is susceptible to kick-load damage that are within physical reach of the crewman, regardless of whether it is in the 'corridor.'
  - ii. Exterior mechanisms in both stowed and deployed position, seen from up to three orthogonal views.
  - iii. General views of EVA worksites.
  - iv. At least one photo of every connector feed-through plate, with the cable harness installed.
  - v. Internal control panels and switches that relate to EVA crew safety.
  - vi. Any deployment/retraction mechanisms
  - vii. Antenna locations.
- 2. The approach for ensuring the imagery documentation is accessible for reference during CEV processing and mission.
- 3. The approach for categorizing, maintaining, organizing, and archiving the imagery.

13.4 **FORMAT**: Contractor format is acceptable. Imagery loaded to ICE as images are processed and categorized.

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

1 PROGRAM: CEV 2 DRD NO.: CEV-T-055  
3 DATA TYPE: 2 4 DATE REVISED: 12/5/2005  
5 PAGE: 1

6 TITLE: Software Maintenance Plan

7 DESCRIPTION/USE:  
To provide government insight into the method, approach, responsibility, and processes to be used by the contractor for maintenance of software and its associated documentation.

8 DISTRIBUTION: As determined by the Contracting Officer.

9 INITIAL SUBMISSION: Per Data Requirements Matrix

10 SUBMISSION FREQUENCY: Per Data Requirements Matrix

11 REMARKS:  
The following document(s) may be used as guidance:  
• IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes  
• IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data

12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 6.2.1.1.

13 DATA PREPARATION INFORMATION:

13.1 SCOPE:  
The Software Maintenance Plan provides insight into the method, approach, responsibility, and processes to be followed for maintenance of software and its associated documentation. For the Software Maintenance Plan, provide separate volumes for each system element (e.g., ground operations, flight operations, mission operations, and spacecraft).

13.2 APPLICABLE DOCUMENTS:  
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)

13.3 CONTENTS:  
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as guidance, the Software Maintenance Plan shall include:  
a. Plan information for the following activities:  
1) Maintenance process implementation.  
2) Problem and modification analysis.  
3) Modification implementation  
4) Maintenance review/acceptance.  
5) Migration.  
6) Software Retirement.  
7) Software Assurance.  
b. Specific standards, methods, tools, actions, procedures, and responsibilities associated with the maintenance process. In addition, the following elements are included:

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- 1) Development and tracking of required upgrade intervals, including implementation plan.
  - 2) Approach for the scheduling, implementation, and tracking of software upgrades.
  - 3) Equipment and facilities required for software verification and implementation.
  - 4) Updates to documentation for modified COTS or non-COTS software.
  - 5) Licensing agreements for COTS
  - 6) Plan for and tracking of operational backup software
  - 7) Approach for the implementation of modifications to operational software (e.g., testing of software in development lab/verification facility prior to operational use).
  - 8) Approach for software delivery process including distribution to facilities and users of the software products and installation of the software in the target environment (including, but not limited to, spacecraft, simulators, Mission Control Center, and ground operations facilities).
  - 9) Approach for providing NASA access to the software version description data (e.g., revision number, licensing agreement).
- 13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.
- 13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-056
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/5/2005
5. **PAGE:** 1
6. **TITLE:** Software User Manual
7. **DESCRIPTION/USE:**  
To define user instructions for a CSCI, a software system or subsystem, or other software- related item.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
The following document(s) may be used as guidance:
  - IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
  - IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6 2 1.1.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Software User Manual defines user instructions for a CSCI, a software system or subsystem, or other software- related item.
- 13.2 **APPLICABLE DOCUMENTS:**  
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)
- 13.3 **CONTENTS:**  
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as guidance, the Software User Manual shall include:
  - a. Software summary including: application, inventory, environment, organization and overview of operation, contingencies and alternate states and modes of operation, security and privacy, and assistance and problem reporting.
  - b. Access to the software: first-time user of the software, initiating a session, and stopping and suspending work.
  - c. Processing reference guide: capabilities, conventions, processing procedures, related processing, data backup, recovery from errors, malfunctions, emergencies, and messages.
  - d. Assumptions, limitations, safety related items/concerns or constraints.
- 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.



- 135 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified.



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code.

g. Software product files (any files needed to install, build, operate, and maintain the software).

134 FORMAT: Electronic format per Section J-2 2.3.2.1.

135 MAINTENANCE: Changes shall be identified and complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-058
3. **DATA TYPE:** 1
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Radio Frequency/Optical ICDs
7. **DESCRIPTION/USE:**  
RF/Optical Interface Control documents define the end to end communications interfaces. NASA will use these ICDs to ensure that all interfaces are compatible and interoperable with other Constellation elements and communications infrastructure.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
These documents shall be consistent with the Constellation Program's integrated plans such as CXP-00101, Constellation Command, Control, Communication, and Information (C3I) Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List).
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.1.3.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
RF/Optical ICDs shall be developed for all communications links (Space to Space and Space to Ground).
- 13.2 **APPLICABLE DOCUMENTS:**  
450-SNUG: Space Network Users' Guide  
CXP-00101: Constellation Command, Control, Communication, and Information (C3I) Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)  
ICD-GPS-200: Navstar GPS Space Segment/Navigation User Interfaces
- 13.3 **CONTENTS:**  
The RF/Opticals ICD shall start at Layer 2 (Data Link Layer) for transmission end and end at Layer 2 (Data Link Layer) on receiving end.  
RF link compatibility analyses - Documents the RF compatibility between CEV communication links and between CEV communication links and other interfacing elements  
The RF/Opticals ICD shall detail the characteristics of the RF communication channel between the CEV, ground stations, Space Network and other Constellation elements including:
  - Frequencies of operation
  - Modulation & Channel Coding
  - Transmitter powers, receiver noise temperatures and antenna performance
  - Data link layer consisting of framing and link establishment, and negotiation protocols.
  - Nominal and contingency EVA communications support

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- 13.4 **FORMAT**: Electronic format per Section J-2 2 3.2.1.
- 13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required, with changes clearly identified.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-059
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/5/2005
5. **PAGE:** 1
6. **TITLE:** Electrical Power System (EPS) Design and Data Book
7. **DESCRIPTION/USE:**  
Documents the power system design, including the input assumptions, the analytical methods used, the results of the analyses and the comparison to applicable quantitative requirements. The comprehensive equipment documentation will provide detailed reference information to support Engineering and Operations throughout the life of the CEV.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.2.
13. **DATA PREPARATION INFORMATION:**
  - 13.1 **SCOPE:**  
The Electrical Power System Design and Data Book documents the results of design, development, and other pertinent studies relating to the electrical power system, including all power generation, storage, and distribution/control equipment, circuit protection, interior and exterior vehicle lighting, and interfaces for ground, mated vehicles, payloads, and portable equipment. End-to-end functional schematics, engineering drawings, and associated lists shall be utilized to the maximum extent possible in performing and providing analysis reports.
  - 13.2 **APPLICABLE DOCUMENTS:**
  - 13.3 **CONTENTS:**  
Volume 1 - Electrical Power System Circuit Protection and Isolation Plan and provisions for establishing, and maintaining electrical circuit protection for the CEV and CEV interfaces (including human safety) with ground maintenance/test facilities, launch facilities, in-flight vehicles, recovery, and re-furbishment facilities. Crewed, EVA, and uncrewed operations for both 'ground' and 'in-flight' activities such as monitoring, testing, diagnostic, safing, fault recovery, and maintenance shall be addressed.  
  
Volume 2 - Electrical Power System Requirements and Design Analysis Reports  
The deliverable shall include:
    - 1) Assumptions, groundrules
    - 2) Subsystem Definition
    - 3) Subsystem Requirements Analyses
      - a. Functional decomposition
      - b. Functional, performance, and interface requirements
      - c. Derived requirements on other systems with analysis that yields the requirements

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## d. Trade studies results

e. Analysis to show the subsystem meets the requirements. In cases where computer math models or programs are utilized, a description of the program along with the source code shall be made available to NASA. The following analyses shall also be documented:

1. Electrical Power System Circuit Protection and Fault Analyses - Documents the circuit protection analysis results to determine correct circuit protection size and trip characteristics. Documents the proper circuit protection sizing that is verified by comparing source fault current with wiring and circuit protection specifications. Documents the fault analysis in which worst case faults are considered from the standpoint of safety or mission compromise to determine if power and circuit redundancy is adequate and to assure that there are adequate circuit protection margins to preclude upstream fault propagation. Documents the analysis of both line-to-ground and line-to-line faults.

2. Electrical Power System Grounding Analysis - Documents the electrical grounding design. Documents the analysis results of the electrical grounding design and consistency with the performance specifications of the various interfacing elements during all phases of ground testing and mission flights.

3. Electrical Power System Voltage Drop Analysis - Documents the analysis results using circuit resistance values based on wire size, wire length, temperature conditions, circuit element resistances, and varying load conditions. Documents voltage drops on all major circuits, loads, and interfaces at varying load conditions.

4. Electrical Power System Transient Analyses - Documents the analysis results using normal and worst case subsystem and system interface conditions (voltage and bus transient and ripple), evaluates the design for proper performance and compatibility, and assures adequate margins between the source and the loads. Also documents the evaluation of power on/off switching transient generation for adverse (out-of-spec.) impacts to the interfacing bus.

Volume 3 - Electrical Power System Architectural Notebook  
Documents the EPS architectural connectivity for all vehicle configurations.

1) This volume shall include connectivity schematics of:

- a. Power generation, power storage, and distribution/control equipment to each other and to each electrical consuming equipment, including interior and exterior lighting
- b. Internal and external interfaces for ground support, portable equipment, payloads, mated vehicles, and human interfaces
- c. Activation/deactivation architecture, dead-facing termination, as well as any temporary or contingency EPS jumpers (includes hardware utilization description)
- d. Thermal and command/data connectivity to the EPS devices.

Volume 4 - Electrical Power System Equipment Description and Performance Data

Comprehensive equipment documentation of the EPS hardware to provide detailed reference information for supporting Engineering and Operations.

1) Detailed Design Description of each EPS device shall include:

- a. Hardware description with functional block diagrams
- b. Internal and external hardware interfaces including mechanical, optical, electrical, thermal interfaces, software interfaces, and human interfaces
- c. Mass and volume properties
- d. Equipment location
- e. Hardware math model (where applicable)
- f. Consumables (if applicable)
- g. Data bandwidths (data rates); Telemetry; Instrumentation description

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- 2) Operational Description of each EPS ORU shall include:
- a. Operational modes including default and commanded states
  - b. Power and thermal profile for each operational mode
  - c. Performance and margin capability
  - d. Natural and induced operating and non-operating environments (examples: min/max pressure and temperature)
  - e. Basic summary of operational activation/deactivation procedures and limitations
  - f. Initialization procedures and parameters
  - g. Day of launch parameters and late-load requirements
  - h. Launch scrub turnaround procedures
  - i. Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures (includes abort safing procedures)
  - j. Fault Detection, Isolation and Recovery
  - k. Diagnostics strategies including plans for In-flight maintenance
  - l. Labeling strategy (consistent with overall CEV labeling strategy)

- 3) Maintainability and testing data shall include:
- a. Test requirements including information on Special Test Equipment design, operations and maintenance.
  - b. Maintainability strategies including sparing provisions, growth and scarring provisions, shelf-life, and long-term storage provisions
  - c. Deliverable end item or equipment identification (part number)
  - d. Predicted reliability assessment
  - e. Component reusability/refurbishment analysis

134 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

135 **MAINTENANCE:** Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.



## DATA REQUIREMENTS DESCRIPTION (DRD)

1 PROGRAM: CEV 2 DRD NO.: CEV-T-060  
3 DATA TYPE: 1 4 DATE REVISED: 12/5/2005  
5 PAGE: 1  
6 TITLE: Electrical Power Quality Specification Requirements Document  
7 DESCRIPTION/USE:  
Establishes electrical power quality and compatibility requirements for the power source interfaces and for the integrated/portable electrical load interfaces. The electrical power quality specification requirements define the power characteristics and the minimum performance and test requirements for loads to be compatible with these characteristics.  
8 DISTRIBUTION: As determined by the Contracting Officer  
9 INITIAL SUBMISSION: Per Data Requirements Matrix  
10 SUBMISSION FREQUENCY: Per Data Requirements Matrix  
11 REMARKS:  
This document must be consistent with the Constellation Program's integrated plans  
12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 6 2 2.  
13 DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
The electrical power quality and compatibility specification requirements establish the power quality interface requirements for the CEV and the CEV power interfaces to ground test facilities, portable loads, and other mated vehicles.  
13.2 APPLICABLE DOCUMENTS:  
13.3 CONTENTS:  
For each major type of distributed power, two electrical power quality and compatibility specification requirement volumes shall be generated. The first volume shall define the power source interface(s) and compatibility requirements, and the second volume shall define the integrated/portable load (electrical consuming equipment) interface(s) and compatibility requirements.  
13.4 FORMAT: Electronic format per Section J-2 2.3.2.1.  
13.5 MAINTENANCE: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-061
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/13/2005
5. **PAGE:** 1
6. **TITLE:** Mechanical Systems Design and Data Book
7. **DESCRIPTION/USE:**  
Documentation of design information for the CEV Mechanical systems. This documentation will provide insight into the contractor's design, as well as detailed reference information to support Engineering and Operations throughout the life of the CEV.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6 2 3.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Mechanical Systems Design and Data Book documents the results of design, development, and other pertinent studies relating to each mechanical system.
- 13.2 **APPLICABLE DOCUMENTS:**  
NASA-STD-5017: Design and Development Requirements for Mechanisms, Sections 1-4
- 13.3 **CONTENTS:**  
The deliverable shall include, as applicable, the subsystem information listed below for each mechanism:
  - 1) Assumptions and groundrules
  - 2) Subsystem Definition
  - 3) Subsystem Requirements Analyses
    - a. Functional decomposition
    - b. Functional, performance and interface requirements
    - c. Derived requirements on other systems with analysis that yields the requirements
    - d. Trade study results
  - 4) Detailed Design Description
    - a. Hardware element descriptions
    - b. Hardware math models
    - c. Mass and volume properties
    - d. Power and thermal profiles
    - e. Schematic layouts, drawings and 3-D solid geometric representations of components
    - f. Data and analyses necessary to support compliance to NASA-STD-5017, Design and Development Requirements for Mechanical Systems, Sections 1-4 requirements, such as thermal tolerance analyses, force margin analyses, and test data. Supporting analyses shall discuss all boundary conditions, inputs, and assumptions used; analytical approaches (models, equations, algorithms) used; results; and conclusions

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- g. Mechanical component stress analysis reports showing margins of safety under all design load conditions
  - h. A list of mandatory inspection points, to be performed during manufacturing, assembly, and testing of the mechanism.
  - i. Interfaces (internal and external hardware interfaces including mechanical, electrical and thermal interfaces, software interfaces, and human interfaces; includes necessary Interface Control Documents)
  - j. Consumables list
  - k. Data bandwidths (data rates); Telemetry; Instrumentation
  - 5) Operational Analyses
    - a. Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight
    - b. Performance and Margin analyses
    - c. Operating environments (natural and induced)
    - d. Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures
    - e. Fault Detection, Isolation and Recovery
    - f. Diagnostic strategies
    - g. Abort analysis
    - h. Launch scrub turnaround plan
    - i. A failure-tolerance diagram or matrix for each mechanism describing the failure tolerance in place to meet the CEV failure-tolerance requirements
  - 6) Maintainability and testing data
    - a. Test requirements including information on Special Test Equipment design, operations and maintenance.
    - b. Maintainability strategies including sparing provisions, growth and scarring provisions, shelf-life, and long-term storage provisions
    - c. Deliverable end item or equipment identification (part number)
    - d. Predicted reliability assessment
    - e. Component reusability/refurbishment analysis
    - f. A record of all test failures, anomalies, and accidents involving qualification or potential flight hardware that are not documented in PRACA reports.
    - g. The results of all verification testing, analyses, and inspections not documented in other test or certification reports, including a narrative explanation of how the testing, analysis and inspection results obtained satisfy the verification requirements
  - 7) References and Indication of any changes from the previous submission
- 13.4 **FORMAT:** Contractor may divide into volumes/books as necessary. Documents shall be electronic format per Section J-2 2.3.2.1.
- 13.5 **MAINTENANCE:** Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

- 1     **PROGRAM:** CEV
- 2     **DRD NO.:** CEV-T-062
- 3     **DATA TYPE:** 2
- 4     **DATE REVISED:** 12/21/2005
- 5     **PAGE:** 1
- 6     **TITLE:** Stress Analysis Report
- 7     **DESCRIPTION/USE:**  
The stress analysis report documents the strength and life integrity of the structure and provides documentation for the structural certification of the hardware. The stress analysis report will establish the strength and life capability of the hardware, provide a method to evaluate proposed changes to the design loads and environment, and will provide data to resolve manufacturing, salvage, and field maintenance problems.
- 8     **DISTRIBUTION:** As determined by the Contracting Officer
- 9     **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10    **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11    **REMARKS:**  
The calculations performed in this report must be checked and verified by the responsible engineering organization.  
  
A complete file of unsubmitted 'back-up' or 'notebook' analysis, including electronic files and spreadsheets, should be maintained by the responsible stress analysts within the originating organization for review by NASA engineering. These unsubmitted supporting analyses should be saved until the hardware has completed its design life.
- 12    **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.3.  
Referenced from SOW Paragraph(s): 6.2.10, 6.2.6
- 13    **DATA PREPARATION INFORMATION:**
- 13.1   **SCOPE:**  
The stress analysis report shall document the strength and life integrity analysis of every structural component in the CEV System.
- 13.2   **APPLICABLE DOCUMENTS:**
- 13.3   **CONTENTS:**  
The stress analysis report must contain the following elements:
  - a. A general description of the system being analyzed.
  - b. A discussion of the methods and assumptions used in the analysis.
  - c. A margin of safety summary table that lists the lowest margin of safety for each part in the system and a cross-referenced page number where the margin calculation is performed.
  - d. Material property references and allowables summary.
  - e. Summary of load conditions and references.  
The stress analysis must be able to be read and understood without having to secure drawings. A sketch of the structure being analyzed should be provided that will describe
  1. What the part is and what it looks like
  2. Where the part is located in the assembly or installation
  3. Where the external loads are applied

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4. Where the reaction loads are located
  5. Drawing numbers for all parts unless already identified in the analysis
  6. Dimensions and tolerances if applicable
- 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1. Microsoft® Word document or Adobe® Acrobat® pdf.
- 13.5 **MAINTENANCE:** NASA approval is required for any of the following modifications to the stress analysis report after its final issue:
- \* When a significant design change has been made to the structure, a new report shall be reissued. A copy of the old analysis will be retained for unmodified structure still in service.
  - \* When analyses are modified to reflect new methods and/or data, the revised report shall be cross-referenced to the old analysis and the changes shall be clearly explained.
  - \* When an old analysis is revised locally by a new analysis, the old pages will be removed and destroyed and the new pages inserted into the report, with a revision identifier.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-063
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/5/2005
5. **PAGE:** 1
6. **TITLE:** Passive Thermal Control Design and Data Book (PTCDDB)
7. **DESCRIPTION/USE:**

The TDDDB is the repository of data for the CEV Passive Thermal Control System. This documentation will provide insight into the contractor's design, as well as detailed reference information to support Engineering and Operations throughout the life of the CEV.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2 4.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**

The Passive Thermal Control Design and Data Book provides a summation and targeted details of the contractor's data, analysis and selections developed for the designs for vehicle systems that provide and manage the Passive Thermal Control System.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**

The PTCDDB shall contain detailed information regarding the passive thermal control design at the CEV component level as well as integrated passive thermal control at the spacecraft level.

The deliverable shall include, as applicable, the subsystem information listed below:

  - 1) Assumptions and groundrules
  - 2) Subsystem Definition including GFE vs. contractor-supplied assumptions
  - 3) Subsystem Requirements Analyses
    - a. Functional decomposition
    - b. Functional, performance and interface requirements
    - c. Derived requirements on other systems with analysis that yields the requirements
    - d. Trade study results
    - e. Analysis to show the subsystem meets the requirements
  - 4) Detailed Design Description
    - a. Detailed Hardware element descriptions (For heater system, this shall include information such as heater size, thermostat set points, redundancy, thermostat/temp sensor locations, sensor error, etc
    - b. In cases where computer math models or programs are utilized, a description of the program along with the source code are to be delivered.
    - c. Mass and volume properties
    - d. Constituent materials

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- e. Thermo-physical and thermo-optical properties
  - f. Interface conductance
  - g. Implementation of phase change materials
  - h. Thermo-electrics
  - i. Thermal profiles in all operational modes
  - j. Component Power Dissipation in all applicable operational modes.
  - k. Schematic layouts, drawings and 3-D solid geometric representations of components
  - l. Interfaces (internal and external hardware interfaces including mechanical and thermal interfaces and any necessary Interface Control Documents)
  - m. Consumables list
  - n. Instrumentation description
  - o. Data bandwidths (data rates); Telemetry
  - 5) Operational Analyses
    - a. Operational scenarios, modes, and constraints including the subsystem's limitations on any aspect of vehicle flight
    - b. Performance and temperature margin analyses (including both predicted and demonstrated thermal margins)
    - c. Operational environments (natural and induced)
    - d. Failure modes and redundancy
    - e. Diagnostics strategies
    - f. Abort analysis
    - g. Launch scrub turnaround plan
  - 6) Maintainability and testing data
    - a. Test requirements including information on Special Test Equipment design, operations and maintenance.
    - b. Maintainability strategies including sparing provisions, shelf-life, and long-term storage provisions
    - c. Deliverable end item or equipment identification (part number)
    - d. Predicted reliability assessment
    - e. Component reusability/refurbishment analysis
  - 7) References and Indication of any changes from the previous submission
- 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1 Microsoft® Word/Excel® based and ASCII, delimited for data; SINDA/FLUINT ASCII file, Thermal Desktop®/RadCAD®, and XML.
- 13.5 **MAINTENANCE:** Changes shall be identified and complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-064
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/5/2005
5. **PAGE:** 1
6. **TITLE:** Passive Thermal Control Mathematical Models and Documentation
7. **DESCRIPTION/USE:**  
Thermal mathematical models (thermal radiation math models and thermal network models) used for design, development, and integrated analysis of the CEV. The accompanying reports document model assumptions, algorithms used, and model use.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.4.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Thermal Math Models and Documentation DRD provides the analytical models used for the design, development, and certification of the CEV Passive Thermal Control System. The models include, but are not limited to:
- a. Thermal radiation math models (component and integrated)
  - b. Thermal network models (component and integrated)
  - c. Thermal environment models
  - d. Parametric analysis models
  - e. Thermal-structural models
  - f. Applicable thermophysical materials and thermo-optical properties
  - g. Scripts and command files, as required, for model execution, pre- and post-processing.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
Thermal radiation math models and thermal network models containing finite element, finite difference, or other analytical descriptions of CEV components, systems, and systems. Documentation shall include node/element maps, thermophysical materials and thermo-optical property assumptions and assignments (beginning-of-life and degraded), and articulation schemes, constraints, and data for articulating systems. Thermal environment analyses shall include pertinent orbital element definition data, and natural environmental constants. This DRD includes models for the passive thermal control system and models to be used for integration with other Constellation elements and the International Space Station.
- 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® based and ASCII, delimited for data; SINDA/FLUINT ASCII file, Thermal Desktop®/RadCAD®, and XML. Temperature data shall be in an



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electronic format to efficiently facilitate combined thermo-elastic stress analysis.

- 13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-065
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/5/2005
5. **PAGE:** 1
6. **TITLE:** Thermal Protection System Design and Data Book (TPSDDB)
7. **DESCRIPTION/USE:**

The TPSTDDDB is the repository of data for the CEV thermal protection system. It documents all data pertinent to the thermal design. This documentation will provide insight into the contractor's design, as well as detailed reference information to support Engineering and Operations throughout the life of the CEV.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.5.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**

The Thermal Protection System Design and Data Book provides a summation and targeted details of the contractor's data, analysis and selections developed for the designs for vehicle thermal protection during ascent and entry phases.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**

The TPSTDDDB shall contain detailed information regarding the thermal protection subsystem design at the CEV component level (penetrations, doors, seals, barriers, etc.) as well as integrated thermal protection system design at the spacecraft level in order to support TPS certification.

The deliverable shall include, as applicable, the subsystem information listed below:

  - 1) Assumptions and groundrules
  - 2) Subsystem Definition including GFE vs. contractor-supplied assumptions
  - 3) Subsystem Requirements Analyses
    - a. Functional decomposition
    - b. Functional, performance and interface requirements
    - c. Derived requirements on other systems with analysis that yields the requirements
    - d. Trade study results
    - e. Thermal protection system stress analysis including pertinent material properties and analysis case descriptions.
    - f. Thermal protection system thermal analysis including methodologies and the experimental data that are used to demonstrate the adequacy of the thermal modeling techniques
    - g. Identification of worst case conditions for all regions of the vehicle.

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- 4) Detailed Design Description
    - a. TPS Materials identification (including diagrams indicating material, thickness, expected thermal performance, resulting structural temperatures, and structural temperature gradients)
    - b. In cases where computer math models or programs are utilized, a description of the program along with the source code are to be delivered.
    - c. Mass and volume properties
    - d. Thermal profiles
    - e. Schematic layouts, drawings and 3-D solid geometric representations of components
    - f. Interfaces (internal and external hardware interfaces including mechanical and thermal interfaces)
    - g. Data bandwidths (data rates); Telemetry
    - h. Instrumentation
  - 5) Operational Analyses
    - a. Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight
    - b. Performance and Margin analyses (including predicted and demonstrated thermal margins)
    - c. Operational environments (natural and induced)
    - d. Failure modes and redundancy data
    - e. Diagnostic strategies
    - f. Abort analysis
    - g. Launch scrub turnaround plan
  - 6) Maintainability and testing data
    - a. Test requirements including information on Special Test Equipment design, operations and maintenance.
    - b. Maintainability strategies including sparing provisions, shelf-life, and long-term storage provisions
    - c. Deliverable end item or equipment identification (part number)
    - d. Predicted reliability assessment
    - e. Component reusability/refurbishment analysis
  - 7) References and Indication of any changes from the previous submission
- 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® based and ASCII, delimited for data; SINDA/FLUINT ASCII file, Thermal Desktop®/RadCAD®, and XML.
- 13.5 **MAINTENANCE:** Changes shall be identified and complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-066
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/5/2005
5. **PAGE:** 1
6. **TITLE:** Thermal Protection System Mathematical Models and Documentation
7. **DESCRIPTION/USE:**  
Thermal mathematical models used for design, development, and integrated analysis of the CEV Thermal Protection System. The accompanying reports document model assumptions, algorithms used, and model use.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.5
13. **DATA PREPARATION INFORMATION:**
  - 13.1 **SCOPE:**  
The Thermal Protection System (TPS) Thermal Math Models and Documentation DRD provides the analytical models used for the design, development, and certification of the CEV Thermal Protection System. The models include, but are not limited to:
    - a. Thermal radiation math models (component, penetrations, seals, barriers, and integrated)
    - b. Thermal network models (component, penetrations, seals, barriers, and integrated)
    - c. Aerothermal and thermal environment models
    - d. Ablation models
    - e. Parametric analysis models
    - f. Thermal-structural models
    - g. Thermal Protection System (TPS) stress analysis models
    - h. Applicable thermophysical materials and thermo-optical properties
    - i. Scripts and command files, as required, for model execution, pre- and post-processing.
  - 13.2 **APPLICABLE DOCUMENTS:**
  - 13.3 **CONTENTS:**  
Thermal radiation math models and thermal network models containing finite element, finite difference, or other analytical descriptions of CEV Thermal Protection System components including penetrations, seals, barriers, and integrated TPS representations. Documentation shall include node/element maps, thermo-optical and thermophysical property data and assignments (beginning-of-life and degraded). Thermal environment analyses shall include pertinent orbital element definition data, and natural environmental constants. Aerothermal environments shall include heating flux distributions and profiles for all regions of the vehicle including penetrations, seals, and barriers. TPS stress models shall include pertinent material properties and analysis case descriptions. This DRD includes models for the Thermal Protection

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System, and models to be used for integration with other Constellation elements and the International Space Station.

- 13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® based and ASCII, delimited for data; SINDA/FLUINT ASCII file, Thermal Desktop®/RadCAD®, and XML. Temperature data will be in an electronic format to efficiently facilitate combined thermo-elastic stress analysis.
- 13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

- |    |                     |    |                                |
|----|---------------------|----|--------------------------------|
| 1  | <b>PROGRAM:</b> CEV | 2  | <b>DRD NO.:</b> CEV-T-067      |
| 3. | <b>DATA TYPE:</b> 2 | 4. | <b>DATE REVISED:</b> 12/5/2005 |
|    |                     | 5. | <b>PAGE:</b> 1                 |
6. **TITLE:** Structural Loads Data Book
7. **DESCRIPTION/USE:**  
To define structural loads for the spacecraft design, development, test, and flight.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.6.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Structural Loads Data Book defines the structural loads to be used for the design of the spacecraft flight and test articles and its associated equipment.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONIENTS:**  
Significant loads encountered for all mission phases during the service life, from manufacturing to end of service, including static, dynamic, steady state, and transient loads shall be documented. Load combinations which occur simultaneously shall be defined.
- 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2 1. Word-compatible document or Adobe® Acrobat® PDF. ASCII text files for tabular data formats.
- 13.5 **MAINTENANCE:** Contractor-proposed changes to this document shall be submitted to NASA for approval.

## DATA REQUIREMENTS DESCRIPTION (DRD)

- |    |                     |    |                                |
|----|---------------------|----|--------------------------------|
| 1  | <b>PROGRAM:</b> CEV | 2  | <b>DRD NO.:</b> CEV-T-068      |
| 3. | <b>DATA TYPE:</b> 3 | 4. | <b>DATE REVISED:</b> 12/5/2005 |
|    |                     | 5  | <b>PAGE:</b> 1                 |
6. **TITLE:** Structures Mathematical Models and Documentation
7. **DESCRIPTION/USE:**  
Delivery of structural static and dynamic math models and associated supporting documentation, including detailed models for stress analysis. The models are used by NASA to understand the vehicle's design and for later problem-solving analyses assuring that system performance and safety requirements will be met.
- The dynamics model is critical to support coupled loads analyses that combine this element with other exploration elements at higher and lower levels of the integrated vehicle design and during different verification phases.
- The stress models, both vehicle-level and detailed component models, are used to facilitate NASA's understanding of the vehicle's design and to assist in the verification review process. Post-delivery problem resolution will also require use of these models.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.6
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
This document covers any mathematical models developed by the Contractor for static and dynamic loads and stress of the CEV System, module, subsystem, and component structures.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
Structural math models used for structural loads and dynamics response, and aero-elastic analyses shall be documented, updated with comment log at the beginning of the model, and delivered as part of the acceptance data package. The log shall make note of relevant assumptions, boundary conditions, node/element numbering, and revisions to the model. Additional model descriptions, included in the comments log, may indicate pertinent modeling parameters, model display, material properties used, and type of model. Verification of models shall be included in the documentation. A list and scope of the structural math models shall be proposed by the contractor and approved by NASA.
- 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1. For models, either NASTRAN.bdf or PATRAN.db format is preferred. With prior NASA consent,

other industry standard native-format or neutral-format model files may be accepted.

- 13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval.



## DATA REQUIREMENTS DESCRIPTION (DRD)

- 1 PROGRAM: CEV 2. DRD NO.: CEV-T-069  
3. DATA TYPE: 2 4 DATE REVISED: 12/12/2005  
5. PAGE: 1  
6 TITLE: Fracture Control Plan  
7 DESCRIPTION/USE:  
The Fracture Control Plan shall define the elements of the fracture control program and the associated management and control responsibilities.  
8. DISTRIBUTION: As determined by the Contracting Officer, and at a minimum shall include the Responsible Fracture Control Authority (RFCA).  
9 INITIAL SUBMISSION: Per Data Requirements Matrix  
10 SUBMISSION FREQUENCY: Per Data Requirements Matrix  
11 REMARKS:  
12. INTERRELATIONSHIP: Parent SOW Paragraph(s): 6.2.6.  
Related DRD(s): CEV-T-070  
13. DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
The Fracture Control Plan will provide hardware-specific information detailing how applicable fracture control requirements will be implemented to prevent catastrophic failure of hardware associated with the propagation of cracks or crack-like defects.  
13.2 APPLICABLE DOCUMENTS:  
NASA-STD-5007: General Fracture Control Requirements for Manned Space Flight Systems  
13.3 CONTENTS:  
The plan shall provide hardware-specific details explaining how fracture control requirements and procedures will be implemented. The plan shall describe the various fracture control approaches that will be applied to all relevant hardware and shall address cracks and crack-like defects that may be present during fabrication, testing, handling, transportation, and operational life. The plan shall contain a listing of all Fracture Critical hardware and parts in accordance with NASA-STD-5007. The plan shall address how fracture critical parts that are susceptible to damage such as impact, corrosion, material degradation, and wear, etc. will be identified. The plan shall identify organizational elements and their responsibilities for activities required to implement the Fracture Control Plan, including reviews of design and structural integrity analyses, configuration control, and generation of required documentation such as DRD CEV-T-070, Fracture Control Summary Report.  
13.4 FORMAT: Electronic format per Section J-2 2.3.2.1 Microsoft® Word/Excel® based, XML, and ASCII, delimited for data.

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- 13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-070
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Fracture Control Summary Report
7. **DESCRIPTION/USE:**  
The Fracture Control Summary report is used to demonstrate compliance with fracture control requirements.
8. **DISTRIBUTION:** As determined by the Contracting Officer, and at a minimum shall include the Responsible Fracture Control Authority (RFCA).
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.6.  
Related DRD(s): CEV-T-069
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Fracture Control Summary Report will provide detailed hardware-specific fracture control analyses and test reports, demonstrating compliance with all applicable fracture control requirements.
- 13.2 **APPLICABLE DOCUMENTS:**  
NASA-STD-5007: General Fracture Control Requirements for Manned Space Flight Systems
- 13.3 **CONTENTS:**  
The report shall comprise an accounting of all assessed hardware and the basis for determining fracture control acceptability for each. The report contents shall include:
  1. a report of damage tolerance analyses or tests
  2. a record of Non-Destructive Evaluation (NDE) inspection or proof-test
  3. a documented description of the load spectrum and material properties used in the analysis
  4. the record of NDE inspection, including the date of inspection, identification of the part inspected, type and level of inspection, and the name of the inspector, including NDE certifications and employer information
  5. if specialized NDE is used, additional data to ensure acceptability and traceability of the process shall be required, including inspector qualifications
  6. supporting data including relevant structural integrity documentation such as detailed design and assembly drawings, specifications, stress reports, materials data and certifications, quality assurance and conformance inspection reports

The Contractor shall keep documents supporting the Fracture Control Summary Report for the life of the hardware. These documents shall be available for audit by NASA.

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- 13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® based, XML, and ASCII, delimited for data.
- 13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

- 1     **PROGRAM:** CEV
- 2     **DRD NO.:** CEV-T-071
- 3     **DATA TYPE:** 3
- 4     **DATE REVISED:** 12/20/2005
- 5     **PAGE:** 1
- 6     **TITLE:** Propulsion Systems Design and Data Book
- 7     **DESCRIPTION/USE:**  
Compilation of requirements, design, analysis, test reports and operational information for each unique propulsion system: including trajectory insertion, orbital maneuvering, and translation and rotation reaction control. This documentation will provide insight into the contractor's designs, as well as detailed reference information to support Engineering and Operations throughout the life of the CEV.
- 8     **DISIRIBUIION:** As determined by the Contracting Officer.
- 9     **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10    **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11    **REMARKS:**  
The following document(s) may be used as guidance:
  - CPIA 655: Guidelines for Combustion Stability Specifications and Verification Procedures for Liquid Propellant Rocket Engines
- 12    **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.7.  
Related DRD(s): CEV-T-081
- 13    **DATA PREPARATION INFORMATION:**
- 13.1   **SCOPE:**  
This set of documents contains the results of design, development, and other pertinent studies relating to the various propulsion systems. Separate volumes shall be developed and maintained for each unique propulsion system on the CEV.
- 13.2   **APPLICABLE DOCUMENTS:**  
AIAA-S-080: AIAA Standard for Space Systems - Metallic Pressure Vessels, Pressurized Structures, and Pressure Components  
AIAA-S-081: AIAA Standard for Space Systems - Composite Overwrapped Pressure Vessels
- 13.3   **CONTENTS:**  
Each volume shall include propulsion subsystem information including, but not limited to:
  1. Subsystem Requirements Analysis
    - (a) Assumptions and groundrules
    - (b) Functional decomposition
    - (c) Functional, performance, life and interface requirements
    - (d) Integrated system level trade studies and subsystem models including model assumptions, model technique, input and output data and resulting wet/dry mass, power, and volume allocations
  2. Detailed Design Description
    - (a) Fluid, electrical, and instrumentation schematics and layouts
    - (b) Propulsion performance calculations including fluid thermal and pressure variation effects

- (c) Propulsion Pressure System description: document the design, analysis, fabrication, test, inspection, operation and maintenance of all vessels, lines/ducts/fittings and components, as well as the integrated subsystem and its assemblies. Included shall be a complete description, material properties, drawings, schematics, finite element analysis results (static and dynamic loads), factor of safety margins, design verification plan and damage control plan as applicable
- (d) Thruster/Engine design descriptions and combustion stability assessments addressing cycle life and accumulated hot fire duration, thermal soak-back with environmental effects, restart capability, bubble ingestion, propellant saturation effects, valve cycle life, and engine/thruster duty cycles limitations as well as required operational duty cycle spectrums with associated accumulated durations, fulfilment of mission derived detailed performance and operational capabilities (including, but not limited to steady-state and pulse mode Isp and impulse bit capability over all possible operational conditions) with adequate margins for the full range of expected and possible operating conditions and life capabilities, and combustion stability, all with correlations to test results and corrections for the flight design application
- (e) Component/line sizing including system pressure flow loss calculations, pressurant blow down models and filtration capacity/sizing analysis, with correlations to test results and corrections for the flight design application
- (f) Propellant acquisition and tank discharge analyses under all expected operating and mission environments, with correlations to test results and corrections for the flight design application
- (g) Fluid system transient analyses including activation, firing, and safing for nominal and contingency modes, with correlations to test results and corrections for the flight design application
- (h) Thermal conditioning and maintenance analysis including propellant storage quality, feed system and engine/thruster/igniter thermal conditioning, and boil off losses for the allowable hot and cold environmental conditions as applicable, with correlations to test results and corrections for the flight design application
- (i) Component design information including vendor component drawings and cross-sections, material usage list, stress analysis and thermal analysis (including safety factors, derating factors, safety margins and rationale), any test reports (including addressing adequate margin for required life capabilities), mill reports, NDE reports, or burst article or qualification test reports that may be available, as well as development, qualification, and production schedules and associated information
- (j) Propellant compatibility assessment and associated data including exposure duration, propellant vapor migration, corrosion, embrittlement, decomposition and leaching effects, with correlations to test results and corrections for the flight design application
- (k) Instrumentation list for flight system and support equipment include sensor, range, units accuracy, drift, and sample rate. Provide details, models, flight algorithms and associated uncertainties for calculated quantities such as fluid quantity gauging, with correlations to test results and corrections for the flight design application
- (l) Overpressure protection design and analysis addressing worst case failure conditions and thermal environments, define MDP/MEOP for the system with associated rationale and analyses, with correlations to test results and corrections for the flight design application
- (m) Interface definition (internal and external hardware and subsystem interfaces including physical, mechanical, electrical and thermal interfaces, software interfaces)
- (n) Propulsion system requirements vs. capabilities summary with supporting rationale and explanations
- (o) Reliability assessment process overview and assumptions as well as

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reliability analysis and process for verifying reliability  
(p) Shelf life and long term storage assessment and rationale  
(q) Useful life assessment and rationale, and disposal approach as applicable  
(r) Simulation tool description, source algorithms/code and validation report, including benchmarks of test results against model predictions

3. Verification Activities not already included in the Master Verification DRD(s)

- (a) Subassembly, assembly, and system verification article(s) detailed design description(s), addressing all engineering deliverables (drawings, models, schematics, hardware configuration and selection, interface requirements and designs, associated analyses and results, manufacturing, assembly, installation, and checkout planning, schedules and requirements, test instrumentation, etc.), differences from the flight configuration and operational conditions and associated rationale(s)
- (b) Flight propulsion system(s) checkout sequencing and associated checkout requirements, setup conditions, constraints and details, and pass/fail criteria as well as associated verification results
- (c) Interface verification approaches and verification results
- (d) Fracture control reports for all propulsion system fracture critical hardware, in accordance with the Fracture Control Plan DRD

4. Test Plans and Reports not already included in the Master Verification DRD(s)

- (a) Development test plans and test reports at the component, assembly and system levels
- (b) Propulsion System Hot Fire and Thermal Conditioning Test Plan(s) and Test Report(s) including the test scope, required schedule milestones, test objectives and rationale, test article architecture, instrumentation requirements, data acquisition requirements, facility requirements, fluid requirements, participant roles and responsibilities, a test matrix identifying test article configurations, test parameters, test durations, number of tests, success criteria, data format requirements, and a discussion of how the test data will be interpreted to satisfy the test objectives. Raw test data shall be made available to NASA. Reports shall document the results of the tests and an assessment of integrated system performance, differences from the flight configuration and operational conditions and associated rationale(s) and and corrections for the flight design application.
- (c) Acceptance test data not already included in the Acceptance Data Package capturing all flight system acceptance results down to the component level.

5. Operational Analyses

- (a) Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight
- (b) Performance and Margin analyses
- (c) Operating Environments (natural and induced)
- (d) Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures
- (e) Failure detection, isolation and recovery design details including diagnostic methods and controls with supporting data, correlations to test results and corrections for the flight design application and rationale
- (f) Component reusability/refurbishment/recertification analysis and maintainability strategy (if applicable)
- (g) Diagnostic strategies including plans for in-flight maintenance
- (h) Initialization procedures and parameters
- (i) Day of launch parameters and late-load requirements
- (j) Abort analysis

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(k) Launch scrub turnaround plan

6) Maintainability and testing data

(a) Test requirements including information on Special Test Equipment design, operations and maintenance.

(b) Maintainability strategies including sparing provisions, growth and scarring provisions, shelf-life, and long-term storage provisions

(c) Deliverable end item or equipment identification (part number)

(d) Predicted reliability assessment

(e) Component reusability/refurbishment analysis

(f) A record of all test failures, anomalies, and accidents involving qualification or potential flight hardware that are not documented in PRACA reports.

(g) The results of all verification testing, analyses, and inspections not documented in other test or certification reports, including a narrative explanation of how the testing, analysis and inspection results obtained satisfy the verification requirements

Content of each submittal must be sufficient to satisfy the objectives of the milestone review for which it is submitted.

13.4 **FORMAT**: Electronic format per Section J-2 2.3 2.1.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.



**DATA REQUIREMENTS DESCRIPTION (DRD)**

- 1     **PROGRAM:** CEV
- 2     **DRD NO.:** CEV-T-072
- 3     **DATA TYPE:** 3
- 4     **DATE REVISED:** 12/19/2005
- 5     **PAGE:** 1
- 6     **TITLE:** Suits, EVA and Survival Crew Equipment Support Systems Design and Data Book
- 7     **DESCRIPTION/USE:**  
Documentation for design information for vehicle Suits, EVA and Survival Crew Equipment support systems. NASA will use this information as a source for insight into the contractor's design of the vehicle interfaces for suits, EVA and survival crew equipment support systems. In addition, this documentation will provide detailed reference information to support Engineering and Operations throughout the life of the CEV.
- 8     **DISTRIBUTION:** As determined by the Contracting Officer
- 9     **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10    **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11    **REMARKS:**
- 12    **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.8.
- 13    **DATA PREPARATION INFORMATION:**
- 13.1   **SCOPE:**  
The Suits, EVA and Survival Crew Equipment Support Systems Design and Data Book provides a summation and targeted details of the contractor's data, analysis and selections developed for the designs for vehicle interfaces for suits, EVA and survival crew equipment support systems including suit/umbilical interfaces, vehicle depressurization/repressurization system interfaces, EVA hatch design and mechanisms, any specialized (i.e., nonstandard, non-government furnished) tools associated with these systems and external restraints and mobility aids.
- 13.2   **APPLICABLE DOCUMENTS:**
- 13.3   **CONTENTS:**  
The deliverable shall include the subsystem information listed below, as applicable:
  - 1) Assumptions and groundrules
  - 2) Subsystem Definition including GFE vs. contractor-supplied equipment assumptions
  - 3) Subsystem Requirements Analyses
    - a. Functional decomposition
    - b. Functional, performance and interface requirements
    - c. Derived requirements on other systems with analysis that yields the requirements
    - d. Trade study result
    - e. Analysis to show the subsystem meets the requirements
  - 4) Detailed Design Description
    - a. Hardware element descriptions
    - b. Mass and volume properties
    - c. Power and thermal profiles

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- d. Schematic layouts, drawings and 3-D solid geometric representations of components
- e. Interface descriptions, dependencies, and requirements
- f. Consumables list and usage/replenishment rates
- g. Data Bandwidth/memory/processor throughput utilization and margin analysis
- h. Telemetry/instrumentation
- 5) Operational Analyses
  - a. Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight
  - b. Performance and Margin analyses
  - c. Operating Environments (natural and induced)
  - d. Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures
  - e. Fault Detection, Isolation and Recovery
  - f. Diagnostic strategies including plans for in-flight maintenance
  - g. Initialization procedures and parameters
  - h. Day of launch parameters and late-load requirements
  - i. Abort analysis
  - j. Launch scrub turnaround plan
  - k. Labeling strategy (consistent with overall CEV labeling strategy)
  - l. Independent design and performance analyses including worst case timing analysis, fault tolerance and hazard identification/mitigation.
- 6) Maintainability and testing data
  - a. Test requirements including information on Special Test Equipment design, operations and maintenance.
  - b. Maintainability strategies including sparing provisions, growth and scarring provisions, shelf-life, and long-term storage provisions
  - c. Deliverable end item or equipment identification (part number)
  - d. Predicted reliability assessment
  - e. Component reusability/refurbishment analysis
- 7) References and Indication of any changes from the previous submission

134 **FORMAT:** Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® based and ASCII, delimited for data.

135 **MAINTENANCE:** Changes shall be identified and complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-073
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Environmental Control and Life Support Design and Data Book
7. **DESCRIPTION/USE:**  
Documentation for design information for vehicle Environmental Control and Life Support systems (ECLSS) including vehicle Active Thermal Control Systems (ATCS). NASA will use this information as a source for insight into the contractor's design of the vehicle ECLSS and ATCS.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
The following document(s) may be used as guidance:
  - MIL-STD-810F: DOD Test Method Standard for Environmental Engineering Considerations and Laboratory Tests, Section 5 and Part 2
  - MSFC-PROC-1831: The Analysis of Nonvolatile Residue Content
  - MSFC-PROC-1832: Sampling and Analysis of Nonvolatile Residue Content on Critical Surfaces
  - MSFC-PROC-404: Gases, Drying and Preservation, Cleanliness Level and Inspection
  - MSFC-SPEC-164B: Specification for Cleanliness of Components for Use in Oxygen, Fuel and Pneumatic Systems (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.9.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Environmental Control and Life Support Systems Design and Data Book provides a summation and targeted details of the contractor's data, analysis and selections developed for the designs for vehicle systems that provide and manage the following:
  1. Active thermal control (cabin temperature/humidity, heat acquisition, transport and rejection, equipment and vehicle systems active thermal control, thermally-controlled storage)
  2. Breathable atmosphere
  3. Cabin pressure
  4. Contaminant control (in the air, in fluids and on surfaces)
  5. Emergency oxygen
  6. Fire/smoke detection and suppression
  7. Environmental monitoring
  8. Water (potable and non-potable)
  9. Waste and trash collection, storage, processing and disposal
  10. Food supply interfaces, processing, preparation and storage
- 13.2 **APPLICABLE DOCUMENTS:**  
JSC 20584: Spacecraft Maximum Allowable Concentrations for Airborne Contaminants

13.3 **CONTENTS:**

1. The deliverable shall include, as applicable, the information listed below:
  - (a) Assumptions and groundrules
  - (b) Subsystem Definition including GFE vs contractor-supplied assumptions
  - (c) Subsystem Requirements Analyses
    1. Functional decomposition
    2. Functional, performance and interface requirements
    3. Derived requirements on other systems with analysis that yields the requirements
    4. Trade study results
    5. Analysis to show the subsystem meets the requirements
  - (d) Detailed Design Description
    1. Hardware element descriptions
    2. Hardware math models
    3. Mass and volume properties
    4. Power and thermal profiles
    5. Schematic layouts, drawings and 3-D solid geometric representations of components
    6. Interfaces (internal and external hardware interfaces including mechanical, electrical and thermal interfaces, software interfaces, and human interfaces; includes necessary Interface Control Documents)
    7. Consumables list
    8. Data bandwidths (data rates); Telemetry; Instrumentation
  - (e) Operational Analyses
    1. Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight
    2. Performance and Margin analyses
    3. Operating Environments (natural and induced)
    4. Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures
    5. Fault Detection, Isolation and Recovery
    6. Diagnostic strategies including plans for in-flight maintenance
    7. Initialization procedures and parameters
    8. Day of launch parameters and late-load requirements
    9. Abort analysis
    10. Launch scrub turnaround plan
  - (f) Maintainability and testing data
    1. Test requirements including information on Special Test Equipment design, operations and maintenance
    2. Maintainability strategies including sparing provisions, growth and scarring provisions, shelf-life, and long-term storage provisions
    3. Deliverable end item or equipment identification (part number)
    4. Predicted reliability assessment
    5. Component reusability/refurbishment analysis
  - (g) References and Indication of any changes from the previous submission
  2. By PDR, the Contractor shall provide to NASA definition of the process to be used for cleanliness of components for use in oxygen, fuel and pneumatic systems. The process must meet or exceed the requirements identified in the following documents:
    - (a) MSFC-SPEC-164B, Specification for Cleanliness of Components for Use in Oxygen, Fuel and Pneumatic Systems (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)
    - (b) MSFC-PROC-404, Gases, Drying and Preservation, Cleanliness Level and Inspection
    - (c) MSFC-PROC-1831, The Analysis of Nonvolatile Residue Content
    - (d) MSFC-PROC-1832, Sampling and Analysis of nonvolatile Residue Content

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on Critical Surfaces

3. By PDR, the Contractor shall identify the standard they intend to use for test methods for environmental engineering. This standard shall meet or exceed the following standard:

(a) MIL-STD-810F, DOD Test Method Standard for Environmental Engineering Considerations and Laboratory Tests, Section 5, and Part 2

4 The following special analyses, design and plan development shall be performed and documented by the Contractor and delivered to NASA by PDR and updated, if needed, by CDR:

(a) Active thermal control design approach, analyses and models

(b) An analysis of atmosphere mixing within the crew cabin and the ISS interconnecting module for Block 1A and 1B; to include an assessment of CEV atmosphere control accommodations for the variations in air flow systems of the ISS docking nodes

(c) An analysis of CO2 and humidity removal rates vs. airflow rate description of the ppO2 control logic

(d) Trace contaminant control system and CO oxidation system sizing analysis and design

(e) Odor and contaminant removal rate and sizing analysis and design

(f) Environmental control strategy for Earth entry and post landing phases; including off-nominal landing contingencies and environments

(g) Potable water quality control plan and associated analysis

13.4 **FORMAT:** Electronic format per Section J-2 2 3 2.1. Microsoft® Word/Excel® based and ASCII, delimited for data; SINDA/FLUINT ASCII file, Thermal Desktop®/RadCAD®, and XML.

13.5 **MAINTENANCE:** Changes shall be identified and complete re-issue of the document is required.

1 PROGRAM: CEV 2. DRD NO.: CEV-T-074  
3. DATA TYPE: 3 4 DATE REVISED: 12/5/2005  
5. PAGE: 1  
6. TITLE: Habitation Accommodations Design and Data Book  
7. DESCRIPTION/USE:  
Documentation for design information for vehicle habitation accommodations systems, vehicle crew health systems interfaces, and countermeasure systems interfaces. NASA will use this information as a source for insight into the contractor's design of the vehicle habitation accommodations systems, vehicle crew health systems interfaces, and countermeasure systems interfaces. This comprehensive documentation will provide detailed reference information to support Engineering and Operations throughout the life of the CEV.  
8. DISTRIBUTION: As determined by the Contracting Officer.  
9. INITIAL SUBMISSION: Per Data Requirements Matrix  
10. SUBMISSION FREQUENCY: Per Data Requirements Matrix  
11. REMARKS:  
NASA will provide crew clothing, portable crew personal items (e.g., relaxation and entertainment systems, mementos), portable medical kits and equipment and medical supplies, portable countermeasures systems. The CEV Contractor shall provide the interfaces (e.g., stowage, operations usage volume, attach points, power/data/thermal interfaces, and other resources required) for these items. The contractor shall design to the interface requirements for these Government-provided items as defined in the Flight Crew Equipment IRD for these subsystems.  
  
The Contractor shall support the Crew Cabin/Cockpit Layout Requirements Team in the area of habitation accommodations crew cabin layout requirements.  
12. INTERRELATIONSHIP: Parent SOW Paragraph(s): 6.2.9.  
13. DATA PREPARATION INFORMATION:  
13.1. SCOPE:  
The Habitation Accommodations Design and Data Book provides a summation and targeted details of the contractor's data, analysis and selections developed for the designs for vehicle systems that provide and manage the following:  
1. Crew 'seats' (i.e., launch and entry crew restraint systems)  
2. Internal restraints and mobility aids  
3. Hygiene systems  
4. Privacy accommodations  
5. Sleep systems  
6. Ambient storage systems  
7. Maintenance and repair systems  
8. In-situ training systems  
9. Housekeeping systems  
10. Noise (acoustics) control systems  
11. Vehicle on-orbit inventory systems  
12. Clothing interfaces  
13. Crew personal items (e.g., relaxation and entertainment systems)

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interfaces

14. Medical systems interfaces (including crew health system interfaces and countermeasure systems interfaces)

13.2 **APPLICABLE DOCUMENTS:**

JSC 20584: Spacecraft Maximum Allowable Concentrations for Airborne Contaminants

13.3 **CONIENIS:**

The deliverable shall include, as applicable, the subsystem information listed below:

- 1) Assumptions and groundrules
- 2) Subsystem Definition including GFE vs. contractor-supplied assumptions
- 3) Subsystem Requirements Analyses
  - a. Functional decomposition
  - b. Functional, performance and interface requirements
  - c. Derived requirements on other systems with analysis that yields the requirements
  - d. Trade studies results
  - e. Analysis to show the subsystem meets the requirements
- 4) Detailed Design Description
  - a. Hardware element descriptions
  - b. Hardware math models
  - c. Mass and volume properties
  - d. Power and thermal profiles
  - e. Schematic layouts, drawings and 3-D solid geometric representations of components
  - f. Interfaces requirements and description (internal and external hardware interfaces including mechanical, electrical and thermal interfaces, software interfaces, and human interfaces; includes necessary Interface Control Documents)
  - g. Consumables list
  - h. Data bandwidths (data rates); Telemetry; Instrumentation
- 5) Operational Analyses
  - a. Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight
  - b. Performance and Margin analyses
  - c. Operating Environments (natural and induced)
  - d. Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures
  - e. Fault Detection, Isolation and Recovery
  - f. Diagnostics strategies, including plans for in-flight maintenance
  - g. Initialization procedures and parameters
  - h. Day of launch parameters and late-load requirements
  - i. Abort analysis
  - j. Launch scrub turnaround plan
- 6) Maintainability and testing data
  - a. Test requirements including information on Special Test Equipment design, operations and maintenance.
  - b. Maintainability strategies including sparing provisions, growth and scarring provisions, shelf-life, and long-term storage provisions
  - c. Deliverable end item or equipment identification (part number)
  - d. Predicted reliability assessment
  - e. Component reusability/refurbishment analysis
- 7) References and Indication of any changes from the previous submission

The following special analyses and plan development shall be performed and documented by the Contractor and provided to NASA by PDR and updated, if needed, by CDR:

- A. Flight Crew Equipment Management Plan

## Crew Exploration Vehicle -- (CEV)

- B. Analysis of hygiene systems interfaces with ECLSS
- C. Stowage/inventory strategy including an analysis of stowage configurations for all mission phases
- D. Crew compartment internal configurations for all mission phases (including placement of all internal restraints and mobility aids)
- E. Crew launch and entry restraint systems ('seats' or equivalent) operations analysis
- F. Critical Care Transport Plan for ill or injured crewmember from point of occurrence to landing; including advanced medical care life support assumptions

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® based, XML, and ASCII, delimited for data.

13.5 **MAINTENANCE:** Changes shall be identified and complete re-issue of the document is required.



1 PROGRAM: CEV 2 DRD NO.: CEV-T-075  
3 DATA TYPE: 3 4. DATE REVISED: 12/5/2005  
5. PAGE: 1  
6. TITLE: Pyrotechnic Subsystem Design and Data Book  
7. DESCRIPTION/USE:  
The Pyrotechnic Subsystem Design and Data Book shall provide documentation of the development, design, testing, integration, verification and operation of the pyrotechnic subsystem for the CEV. NASA will use this information as a source for insight into the Contractor's design of the CEV pyrotechnic subsystem, especially with respect to reliability and safety. In addition, this documentation will provide detailed reference information to support Engineering and Operations throughout the life of the CEV.  
8. DISTRIBUTION: As determined by the Contracting Officer.  
9. INITIAL SUBMISSION: Per Data Requirements Matrix  
10. SUBMISSION FREQUENCY: Per Data Requirements Matrix  
11. REMARKS:  
The Contractor shall plan pyrotechnic systems to be designed, fabricated, verified, and operated in accordance with JSC 62809, Human Rated Spacecraft Pyrotechnic Specification.  
12. INTERRELATIONSHIP: Parent SOW Paragraph(s): 6.2.10.  
13. DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
The Pyrotechnics subsystem includes all explosively-operated devices, explosive initiators/detonators, pressure cartridges, firing units/controllers, and energy transmission lines (excluding vehicle wiring) as described in JSC 62809, Human Rated Spacecraft Pyrotechnic Specification.  
13.2 APPLICABLE DOCUMENTS:  
JSC 62809: NASA Human Rated Spacecraft Pyrotechnic Specification  
13.3 CONTENTS:  
The Pyrotechnic Subsystem Design and Data Book shall provide documentation of the development, design, testing, integration, verification and operation of the pyrotechnic subsystem.  
It shall include the following data as applicable:  
1) Assumptions and groundrules  
2) Subsystem Definition including GFE vs. contractor-supplied assumptions  
3) Subsystem Requirements Analyses  
a. Functional decomposition  
b. Functional, performance and interface requirements  
c. Derived requirements on other systems with analysis that yields the requirements  
d. Trade study result  
e. Analysis to show the subsystem meets the requirements  
4) Detailed Design Description

- a. Hardware element descriptions including sourcing approach for initiators
  - b. Mass and volume properties
  - c. Power and thermal profiles
  - d. Schematic layouts, drawings and 3-D solid geometric representations of components
  - e. Interface requirements and description (internal and external hardware interfaces including mechanical, electrical and thermal interfaces, software interfaces, and human interfaces, including safing provisions for ground processing, servicing and pre-flight operations; includes necessary Interface Control Documents)
  - f. Consumables list
  - g. Data Bandwidth
  - h. Telemetry/instrumentation
- 5) Operational Analyses
- a. Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight
  - b. Subsystem operational plan and description including command and control (arming/firing) approach, nominal and off-nominal operational scenarios, servicing and safing procedures, and Day of Launch/Day of Landing activities
  - c. Performance and Margin analyses
  - d. Operating Environments (natural and induced)
  - e. Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures
  - f. Fault Detection, Isolation and Recovery
  - g. Diagnostic strategies including plans for in-flight maintenance
  - h. Initialization procedures and parameters
  - i. Abort analysis
  - j. Launch scrub turnaround plan
- 6) Maintainability and testing data
- a. Test requirements and ground test reports and results.
  - b. Maintainability strategies including sparing provisions, shelf-life, and long-term storage provisions
  - c. Deliverable end item or equipment identification (part number)
  - d. Predicted reliability assessment/analysis
- 7) References and Indication of any changes from the previous submission
- 13.4 **FORMAT:** Electronic format per Section J-2 2 3.2.1. Microsoft® Office-compatible for data and reports, PDF for drawings/schematics, and XML
- 13.5 **MAINTENANCE:** Changes shall be identified and complete re-issue of the document is required.

## DATA REQUIREMENTS DESCRIPTION (DRD)

1. PROGRAM: CEV 2. DRD NO.: CEV-T-076  
3. DATA TYPE: 3 4. DATE REVISED: 12/5/2005  
5. PAGE: 1  
6. TITLE: Recovery Systems Design and Data Book  
7. DESCRIPTION/USE:  
This DRD documents the recovery system design, rationale, selections, development, testing, manufacturing records, and certification data. The comprehensive documentation will provide detailed reference information to support Engineering and Operations throughout the life of the CEV.  
8. DISTRIBUTION: As determined by the Contracting Officer.  
9. INITIAL SUBMISSION: Per Data Requirements Matrix  
10. SUBMISSION FREQUENCY: Per Data Requirements Matrix  
11. REMARKS:  
12. INTERRELATIONSHIP: Parent SOW Paragraph(s): 6.2.11.  
13. DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
The Recovery Systems Design and Databook documents the design and development of the recovery system.  
13.2 APPLICABLE DOCUMENTS:  
13.3 CONTENTS:  
The subsystem information listed below will be provided for each component, where applicable:  
1) Assumptions and groundrules  
2) Subsystem Definition  
3) Subsystem Requirements Analyses  
a. Functional decomposition  
b. Functional, performance and interface requirements  
c. Derived requirements on other systems with analysis that yields the requirements  
d. Trade study results  
e. Analysis to show the subsystem meets the requirements  
f. Component-level structural stress analysis process and assumptions, including safety factors, derating factors, safety margins and rationale  
4) Detailed Design Description  
a. Hardware element descriptions including supporting data needed to completely understand the operation of the recovery system (including packing density selection and rationale);  
b. Packing and rigging procedure development process (overview of content, use of inspection points, who performs the inspections, etc.), rationale, and copy of procedures  
c. Hardware math models  
d. Mass and volume properties and moments of inertia  
e. Power and thermal profiles  
f. Schematic layouts, drawings and 3-D solid geometric representations of components, including recovery sequence of events,

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hardware assemblies, and components

g. Interfaces (internal and external hardware interfaces including mechanical (e.g. parachute attachment points, sling routing, sling loading (including magnitude, direction of the loading and load sharing between the slings), sling tiedown locations, insulation, surface roughness and curvature where soft goods come into contact with vehicle, and compartments (e.g. restraints, smooth walls, no sharp edges, venting)), electrical and thermal interfaces, software interfaces, and human interfaces; includes necessary Interface Control Documents)

h. Materials selections and rationale

i. Consumables list

j. Data bandwidths (data rates); Telemetry; Instrumentation

5) Operational Data and Analyses

a. Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight

b. Performance and Margin analyses

c. Operating environments (natural and induced) and appropriate analyses

d. Failure modes and redundancy philosophy/rationale including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures

e. Fault Detection, Isolation and Recovery

f. Predicted reliability analysis and process for achieving demonstrated reliability

g. Reliability assessment process overview and assumptions

h. Initialization procedures and parameters

i. Nominal and abort scenario sequence of events and timelines

j. Launch scrub turnaround plan

6) Maintenance and testing data

a. Component reusability/refurbishment analysis

b. Shelf life and long term storage assessment and rationale

c. Diagnostics and maintainability strategies

d. Useful life assessment and rationale

e. Repair philosophy, process, and rationale

f. Test and flight hardware storage and rationale

g. Description/results of ground testing/analysis for both soft materials and metallic components, including narrative explanation of how the testing, analysis and inspection was performed and how the results obtained satisfy the verification requirements, if not provided in another DRD

h. Development and qualification test concept and rationale

i. Hardware inventory

7) Special documentation on drop tests for the recovery system

a. Drop test plans and test philosophy

b. Drop test procedures and matrix including test configuration and test objectives, test concept (drop zone, storage of drop-related hardware, shipping, etc), techniques, analysis, and test planning and reporting

c. Drop test readiness review data, including test hardware configuration for the test, status/disposition of previous test's or any open anomalies, damage maps, use history, any configuration changes that were implemented during the preparations, results of tests that have been conducted in support of anomaly resolution or design changes, stress analysis and safety margins for all components, test objectives and success criteria, test trajectory, sequence and timeline, performance predictions, predicted loads and performance, rigging details, procedures or flight rule changes/readiness, go/no criteria, contingency plans, and test/range services

d. Drop test reports, including test configuration and objectiveness, specific hardware used, test trajectory, test results, test anomalies, and test conclusions

e. Photography and video documentation of tests, packing, and

## Crew Exploration Vehicle - (CEV)

## rigging

- f. Packing and rigging procedures
- g. Post-test inspection procedures
- h. Post flight data and hardware inspection review package

i. Anomaly log maintained to track drop anomalies. The log should include anomaly title, description, impact of the anomaly, resolution, and status (i.e. open or closed)

8) References and Indication of any changes from the previous submission

13.4 **FORMAT**: Electronic format per Section J-2.2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-077
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/5/2005
5. **PAGE:** 1
6. **TITLE:** Recovery Systems Simulation Models and Documentation
7. **DESCRIPTION/USE:**  
Delivery of recovery system math models, descriptions, analyses results and associated supporting documentation, including detailed models for stress analysis. These models are used to understand the system's design and to assess critical design decisions and system performance.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.11.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The document provides details of the models developed for the recovery systems, including parachute assemblies, equipment for impact attenuation and floatation and the recovery system interfaces to the vehicle.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The document shall include the models used in the design, development, and assessment of the recovery system. For each model, include the model descriptions, applicable natural environment constraints and assumptions. These models include the following:
  1. Trajectory development for recovery sequences
  2. Selection of disreefing timing
  3. Parachute inflation, staging, sling, extraction and energy modulator stripout loads
  4. Performance assessment including descent rate predictions
  5. Component-level stress analyses (including safety factor, design factor, working loads, pull test results, and safety margins),
  6. Reliability analysis
  7. Landing attenuation device related-analyses
  8. Analysis of any auxiliary mechanisms, such as floatation devices, used to stabilize or orient the spacecraft after water landing. Documentation shall include assumptions, model description and model verification. The analyses shall include pertinent vehicle data.
- 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1. Applications should be industry standard and gain NASA consent before delivery.
- 13.5 **MAINTENANCE:** Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

- |    |                     |    |                                 |
|----|---------------------|----|---------------------------------|
| 1. | <b>PROGRAM:</b> CEV | 2  | <b>DRD NO.:</b> CEV-T-078       |
| 3. | <b>DATA TYPE:</b> 3 | 4. | <b>DATE REVISED:</b> 12/20/2005 |
|    |                     | 5  | <b>PAGE:</b> 1                  |
6. **TITLE:** GN&C Design and Data Book
7. **DESCRIPTION/USE:**  
To provide documentation for vehicle Guidance, Navigation, and Control (GN&C) subsystem design information. This documentation will provide insight into the contractor's design, as well as detailed reference information to support Engineering and Operations throughout the life of the CEV.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.12.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
Provides a summation and targeted details of the contractor's data, analysis and selections developed for the GN&C subsystem, including GN&C sensors.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The GN&C Design and Data Book is divided into four volumes. Volume 1 is the Guidance System Design and Data Book. Volume 2 is the Navigation System Design and Data Book. Volume 3 is the Control System Design and Data Book. Volume 4 is the Integrated GN&C System Design and Data Book.
1. Volumes 1 through 3 shall each contain the following generic design and data information. Additional data required for each specific volume is listed below this section.
- (a) Assumptions and groundrules
  - (b) Subsystem Definition including architecture design and GFE vs. contractor-supplied assumptions
  - (c) Subsystem Requirements Analyses
    - 1. Functional decomposition
    - 2. Functional, performance and interface requirements
    - 3. Derived requirements on other systems with analysis that yields the requirements
    - 4. System Trade study results
    - 5. Analysis to show the subsystem meets the requirements
  - (d) Detailed Design Description
    - 1. Hardware element descriptions and principles of operation including description of system modes
    - 2. Hardware math models
    - 3. Mass and volume properties
    - 4. Power and thermal profiles

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5. Architecture diagram, schematic layouts, drawings and 3-D solid geometric representations of components
  6. Interface requirements and description (internal and external hardware interfaces including mechanical, electrical and thermal interfaces, software interfaces, and human interfaces; includes necessary Interface Control Documents)
  7. Consumables list
  8. Data Bandwidth/memory/processor throughput utilization and margin analysis
  9. Telemetry/instrumentation
  - (e) Operational Analyses
    1. Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight
    2. Performance and Margin analyses
    3. Operating Environments (natural and induced)
    4. Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures
    5. Fault Detection, Isolation and Recovery
    6. Diagnostic strategies including plans for in-flight maintenance
    7. Initialization procedures and parameters
    8. Day of launch parameters and late-load requirements
    9. Abort analysis
    10. Launch scrub turnaround plan
    11. Labeling strategy (consistent with overall CEV labeling strategy)
  - (f) Maintainability and testing data
    1. Test requirements including information on Special Test Equipment design, operations and maintenance.
    2. Maintainability strategies including sparing provisions, growth and scarring provisions, shelf-life, and long-term storage provisions
    3. Deliverable end item or equipment identification (part number)
    4. Predicted reliability assessment
    5. Component reusability/refurbishment analysis
    6. Developmental Test and Evaluation Guidelines (test matrix, pass/fail criteria, developmental flow diagram, developmental and evaluation tools)
2. In addition to the data listed in section A above, Volume 1 (the Guidance System Design and Data Book) shall contain the following data:
- (a) General Design Guidelines
    1. Stability (Gain and Phase Margins)
    2. Performance (Step response, Flight Phase Discontinuities)
    3. Operational Envelope (Dynamic pressure, Body Rates, Attitude Limits, Load Limits)
    4. Digital Signal Processing (computation rates, end-to-end data latency for all control loops)
  - (b) Longitudinal Design Guidelines
  - (c) Lateral-Directional Design Guidelines
  - (d) Algorithm Design (Flight phase transition logic, equation derivations)
3. In addition to the data listed in section A above, Volume 2 (the Navigation System Design and Data Book) shall contain the following data:
- (a) General Design Guidelines
    1. Performance
    2. Digital Signal Processing
    3. Sensor Characteristics & Math Models
  - (b) Algorithm Design (equation derivations, Kalman Filter equations, state vector propagation, State Vector update and Covariance Matrix, Reference frames, Navigation phases and major modes)
4. In addition to the data listed in section A above, Volume 3 (the



Control System Design and Data Book) shall contain the following data:

- (a) General Design Guidelines
  - 1. Stability (Gain and Phase Margins)
  - 2. Performance (Step response, Command Tracking Response, Disturbance Rejection, Control Authority)
  - 3. Operational Envelope (Dynamic pressure, Body Rates, Attitude Limits, Load Limits, Winds/Gust/Turbulence)
  - 4. Digital Signal Processing (computation rates, end-to-end data latency for all control loops)
  - 5. Sensor Characteristics (I/O fidelity, latency) & Math Models
  - 6. Structural modes notch filter design
  - 7. Handling qualities
- (b) Longitudinal Design Guidelines
- (c) Lateral-Directional Design Guidelines
- (d) Algorithm Design (equation derivations, system lead/lag requirements, filters, gains, hysteresis, deadbands, mode logic)

5. Volume 4 (the Integrated GN&C System Design and Data Book) shall contain the following data:

- (a) General Design Guidelines
  - 1. Stability (Integrated G&C Gain and Phase margins)
  - 2. Performance (End to End testing)
  - 3. Operational Envelope
- (b) Developmental Test and Evaluation Guidelines (test matrix, pass/fail criteria, developmental flow diagram, developmental and evaluation tools)

6. The following data is available in other DRD's therefore listing the DRD and section where the data can be found is sufficient.

- (a) Failure Modes and Effect Analysis
- (b) Software Requirements and Specifications
- (c) Interface Requirements
- (d) Databases
  - 1. Vehicle Specification (vehicle geometry, mass properties)
  - 2. Aerodynamic data
  - 3. Environment model
  - 4. Propulsion model [ISP, Thrust profile]
  - 5. Small Perturbation Equations of Motion
  - 6. Flex and propellant slosh
  - 7. Modal results at sensor locations
- (e) Parachute/Parafoil model

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE:** Changes shall be identified and complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

- |   |                     |   |                                 |
|---|---------------------|---|---------------------------------|
| 1 | <b>PROGRAM:</b> CEV | 2 | <b>DRD NO.:</b> CEV-T-079       |
| 3 | <b>DATA TYPE:</b> 2 | 4 | <b>DATE REVISED:</b> 12/13/2005 |
|   |                     | 5 | <b>PAGE:</b> 1                  |
- 6 **TITLE:** CEV Wiring Plan
- 7 **DESCRIPTION/USE:**  
The CEV Wiring Plan describes the process by which electrical wires and fiber optic cables are defined, fabricated, routed, installed, and verified for the CEV. NASA will utilize the contractor's CEV Wiring Plan to ensure that the contractor's approach for wiring harness definition, production, management and control is acceptable for the accomplishment of CEV Project objectives.
- 8 **DISTRIBUTION:** As determined by the Contracting Officer.
- 9 **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10 **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11 **REMARKS:**  
The Wiring subsystem shall be designed, implemented and verified in compliance with the applicable documents defined in SOW sections 2.1.9.1 Materials and Processes, 2.1.9.2 Electromagnetic Compatibility, and 6.2.2 Electrical Power Subsystem.
- 12 **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.13.  
Referenced from SOW Paragraph(s): 6.2
- 13 **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Wiring Subsystem provides the power, data and command paths, both electrical and optical, required to test, operate, verify and certify the CEV throughout its life cycle. The Wiring Subsystem also includes electrical and optical production breaks, access points and service panels used to support nominal and off-nominal testing, calibration, operation and safing of the CEV, as well as any dynamic electrical/optical panels or connectors needed to make/break connectivity between the CEV and other Constellation elements or external equipment from pre-launch processing through recovery.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The CEV Wiring Plan shall include the following:  
a) Description of the process for defining and organizing the CEV electrical and optical command, data and power signals in sufficient detail to support population of the CEV Wiring Database with functional paths, signal paths, signal end points as well as manufacturing information including parts data, conductor and shield terminations, connector and signal designations, and special instructions.  
b) Description of the process for identifying the electrical panels, production breaks and access points needed to assemble, test, operate, service, safe and troubleshoot the CEV.  
c) Description of the process for identifying the dynamic electrical/optical separation panels and connectors needed to make or

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break electrical and optical connections between the CEV and other Constellation elements or external equipment from launch through recovery.

d) Description of the process for defining the routing of electrical wiring and fiber optic cabling on the CEV including the appropriate separation of signal types and redundant strings and provisions to preclude inadvertent activation of critical functions. A primary output of the routing process is a definition of wire/cable length including component avoidance/clearance, structural expansion/contraction, minimum bend radius and service loop considerations.

e) Description of the process for fabricating and installing electrical wiring and fiber optic cabling on the CEV including location of final terminations (jig or spacecraft), harness attachment approach, harness bundling techniques, and harness and connector identification and labeling.

f) Provisions for ensuring the physical integrity of the electrical/optical wiring and cabling during vibration environments including self locking connectors, use of safety wire and/or other motion prevention techniques, and harness lacing/strapping techniques.

g) Traceability of parts and materials, tools (calibration) and labor (training and certification) used to fabricate and install the electrical and optical harnesses and cabling.

h) Provisions for verifying the integrity of the fabricated and installed electrical/optical wiring and connections as appropriate to their function, including continuity, dielectric withstanding voltage, insulation resistance, voltage standing wave ratio, and time domain reflectrometry.

i) Provisions for verifying the integrity of the installed optical cabling and connections.

j) Description of the process for monitoring, tracking and controlling the progress of CEV electrical and optical harness/cable fabrication, routing, installation and verification including the inspection processes and discrepancy tracking and resolution processes.

k) Description of the process for identifying, implementing, tracking and resolving drawing change traffic for electrical and optical signal paths during all phases of vehicle design, fabrication, assembly, testing and operation.

l) Provisions for collecting and recording mass properties data for electrical and optical harnesses/cabling during the fabrication and installation process.

m) Identification of Approved Parts List for connectors, wiring and general electrical supplies

n) Description of the process for sizing electrical conductors (AWG) including physical robustness, current limit, temperature rise limit, voltage drop, and design margin.

o) Description of the process for maintaining configuration control over the wiring subsystem to support powered testing including production/verification status of connectors and wiring (e.g., signal routed, terminated, verified, safed), and the physical status of the connectors on the spacecraft (e.g., mated, de-mated or safed).

13.4 **FORMAI:** Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE:** Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of this document is required with changes clearly identified.

## **Crew Detects Odor, Atmosphere Recovery Efforts Under Way**

An emergency was declared on the International Space Station shortly before 7:30 a.m. EDT when the Expedition 13 crew reported an odor in the Zvezda Service Module. The crew is no longer in emergency status. Recovery efforts are now under way by scrubbing the atmosphere.

Expedition 13 Commander Pavel Vinogradov reported to Russian flight controllers at about 7:45 a.m. that the situation had stabilized and that he cleaned up a chemical near the Elektron oxygen generation system.

International Space Station \_\_\_\_ Mike Suffredini said that the odor's source was a spill of the potassium hydroxide. He also said the chemical is an irritant. "It is not a chemical that is life-threatening to the crew," Suffredini said.

Flight controllers instructed the crew to put on protective equipment – goggles, surgical masks and gloves – during the recovery efforts

NASA ISS Science Officer Jeff Williams has been close contact with Mission Control Houston.

The Expedition 13 crew is expected to return to normal operations in \_\_\_\_.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-026
3. **DATA TYPE:** 1
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Spectrum Management Documents
7. **DESCRIPTION/USE:**

Spectrum Management documentation is required to request frequency authorization for each communication link in accordance with NTIA Manual of Regulations & Procedures for Federal Radio Frequency Management (May 2003 Edition, May 2005 Revisions) Chapter 10. NASA will use this information to request frequency authorization for all RF/optical devices. Authorization is requested by NASA with contractor's participation.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**

These documents shall be consistent with the Constellation Program's integrated plans such as CXP-00101, Constellation Command, Control, Communication, and Information (C3I) Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List).
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.9.2.
13. **DATA PREPARATION INFORMATION:**
- 13.1. **SCOPE:**

Spectrum Management documentation is required for all RF/Optical devices in the Crew Exploration Vehicle.
- 13.2. **APPLICABLE DOCUMENTS:**

CXP-00101: Constellation Command, Control, Communication, and Information (C3I) Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)

NTIA Manual: National Telecommunications and Information Administration (NTIA) Manual of Regulations & Procedures for Federal Radio Frequency Management (May 2003 Edition, May 2005 Revisions) Chapter 10
- 13.3. **CONTENTS:**

The Spectrum Management Report shall include:

Forms NTIA-33 - Transmitter Equipment Characteristics, NTIA-34 -Receiver Equipment Characteristics, & NTIA-35 -Antenna Equipment Characteristics shall be completed by the contractor for each RF system for operational vehicle.

RF link compatibility analyses - Documents the RF compatibility between CEV communication links and between CEV communication links and other interfacing elements.

Power Flux Density analysis - Analysis that shows that all modes of operation meet Interdepartmental Radio Advisory Committee flux density

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requirements according to NTIA Manual: NTIA Manual of Regulations & Procedures for Federal Radio Frequency Management (May 2003 Edition, May 2005 Revisions) Chapter 8 (paragraph 8.2.36) for RF radiation impinging on the Earth.

134 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

135 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required, with changes clearly identified.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-027
3. **DATA TYPE:** 1
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Electrical, Electronic, and Electromechanical Parts Management and Implementation Plan
7. **DESCRIPTION/USE:**  
To define and document the contractor's requirements, system and implementation plan for controlling the selection, acquisition, traceability, testing, handling, packaging, storage and application of Electrical, Electronic and Electromechanical (EEE) Parts for flight and critical ground support equipment..
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.9.3.  
Referenced from SOW Paragraph(s): 6.2
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The EEE Parts Management and Implementation Plan defines Contractor's approach to accomplishing the electrical, electronic, and electromechanical parts control requirements and tasks.
- 13.2 **APPLICABLE DOCUMENTS:**  
JPR 8080.5, E-22: JSC Design and Procedural Standards, Section E22, Ionizing Radiation Effects  
JPR 8080.5, E-7: JSC Design and Procedural Standards, Section E-7, Electrical Components - Restrictions on Use
- 13.3 **CONTENTS:**  
The contractor's EEE Parts Management and Implementation Plan shall include the following:
  1. Parts Selection: The Parts Management and Implementation Plan shall describe a concurrent engineering process, integrated with hardware design, in which parts are selected for use on the basis of suitability for the intended application. The plan shall identify application grades, parts that are considered standard for each grade (i.e. 'class B), the up screening requirements to use a lower grade part in a higher grade application, and how other (nonstandard) parts will be evaluated, approved for flight and controlled. The plan shall describe how EEE parts selection shall be driven by the performance demands, environmental and circuit applications, reliability (necessary for the satisfactory performance of the systems in which they are used) and maintenance allocations defined by the equipment specifications, how EEE parts shall be selected based on the suitability for their applications and proven qualifications to the requirements of their specifications.

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2. Non-standard EEE Parts Documentation: The EEE Parts Management and Implementation Plan shall document the process for non-standard parts requests. This process shall include supporting documentation including specifications, and shall be submitted for NASA approval prior to procurement. Non-standard parts requests shall identify and provide rationale for non-standard EEE part selections, clearly documenting justification for use, suitability for the application and environment, and qualification status.
3. EEE Parts Obsolescence Management: The EEE Parts Management and Implementation Plan shall address the Contractor's approach to mitigating EEE parts obsolescence.
4. Audits and Survey's: The EEE Parts Management and Implementation Plan shall include a process for surveying suppliers and manufacturers for the value-added services or products. In addition, a process documenting pre-award surveys shall be included. Pre-award survey shall, as a minimum, include sites performing:
  - a. Screening and testing,
  - b. Destructive Physical Analysis (DPA),
  - c. Failure analysis,
  - d. Radiation laboratories
5. Destructive Physical Analysis: The EEE Parts Management and Implementation Plan shall describe the requirements for performing Destructive Physical Analysis (DPA) on EEE parts to qualify or screen batches of parts to be utilized. This plan shall define when DPA will be performed, the DPA requirements by part type, and the process to disposition parts with anomalies.
6. Part Stress Analysis: The EEE Parts Management and Implementation Plan shall document the derating criteria for worst case environments, operating conditions, and duty cycle, by part type (i.e. Integrated Circuits (ICs), resistors, capacitor, etc) to be applied to the hardware, and actions necessary to correct any deficiencies.
7. Controlling specifications: The EEE Parts Management and Implementation Plan shall define parts that are to be controlled by specifications and the minimum specification contents. As a minimum the contents shall include:
  - a. Complete identification of the part.
  - b. Physical, environmental, and performance specifications.
  - c. Reliability requirements, including inspections and tests for qualification, acceptance, and lot sampling.
  - d. Special explicit requirements such as screening and burn-in, X-ray, ionizing radiation, single event effects, and positive particle protection (e.g., coating, Particle Impact Noise Detection (PIND))
  - e. Special handling, packaging, and storage requirements.
  - f. Documentation, data retention, and submittal requirements.
8. As Designed (Where Used) Parts List: The EEE Parts Management and Implementation Plan shall define how to prepare, submit and maintain an as-designed (e.g., where-used) EEE parts list. The list contents shall include, as a minimum:
  - a. Generic part type and name,
  - b. Common designation,
  - c. Controlling specification number,
  - d. Identification of authorized sources,
  - e. Quantity used,
  - f. Package type,
  - g. Qualification and Non-Standard status, and
  - h. Next higher assembly.



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9. Part Qualification: The EEE Parts Management and Implementation Plan shall define how EEE parts will be qualified, when parts shall be requalified, and the qualification status of the parts will be documented.

10. Design Configuration Acceptability and Control: The EEE Parts Management and Implementation Plan shall address how the selected parts for a design are reviewed for application and environment suitability, how the parts quality and reliability will meet the operational performance requirements, and if the parts are being used within the specific device ratings. The selection process, technical acceptability of devices, application documentation and review results shall be available to NASA to support hardware design reviews, certification, acceptance reviews, problem resolutions, and ground and flight operations. Key elements are as-designed-parts lists, application stress analyses (including radiation effects), and nonstandard parts acceptability assessments.

11. Parts Procurement: The EEE Parts Management and Implementation Plan shall address how the Contractor will select, qualify, control, and monitor parts manufacturers. The plan shall address the Contractor's source inspections, receiving inspection (including destructive physical analysis), and stocking and handling procedures prior to and during assembly. These procedures shall address how the Contractor will avoid the procurement and any subsequent installation of parts or 'lots' of parts subject to conditions identified in Government-Industry Data Exchange Program (GIDEP) and NASA ALERT's. This section of the plan shall ensure that the selection and use of the parts will not have an 'obsolescence' issue to the greatest extent possible.

12. Commercial Off-The-Shelf/Off the Shelf (COTS/OTS) hardware: The EEE Parts Management and Implementation Plan shall address the use of COTS sub-assemblies, and shall define screening, non-standard parts request, and risk assessment requirements. The analysis of COTS/OTS sub-assemblies shall include as a minimum:

- a. A review of the as-designed and as-built EEE parts list (or equivalent) as applicable, and supporting documentation (e.g., procurement specifications, upgrade specifications, waivers, deviations, etc.).
  - b. A review of fabrication processes, history, GIDEP, and ALERTS.
  - c. Identification of EEE parts that are obsolete or which may be nearing obsolescence.
  - d. An application/derating analysis at the EEE part level shall be developed.
  - f. A test or assessment of the OTS hardware and/or associated EEE parts for susceptibility to the space radiation, micro-gravity and vacuum environment.
  - g. A review process considering and identifying any available prior history of successful operations, previous space flight history, failures, and causes of failures for EEE parts in the proposed hardware.
  - h. Identification of any known life limiting factors that may affect the intended useful life of the hardware in the application, such as use of aluminum electrolytic capacitors.
  - i. Rationale and plan for the certification of OTS hardware.
  - j. Any other available data that may be pertinent to the review process.
- The EEE Parts Management and Implementation Plan shall also address the use of COTS sub-assemblies for which insufficient parts information is available. In these cases, the plan shall identify how parts used in COTS sub-assemblies may be qualified (i.e. by environmental and accelerated life testing at the COTS sub-assembly level).

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13. Parts Problem Reporting and Corrective Action: The EEE Parts Management and Implementation Plan shall address a formal and controlled closed-loop system for the reporting, analysis, correction/prevention, and data feedback of SRU end item failures.

14. Radiation Effects:

The EEE Parts Management and Implementation Plan shall include the requirements for the content of the Ionizing Radiation Test and Analysis plans, the Ionizing Radiation Test Procedure and the Ionizing Radiation Test and Analysis report.

15. Data Retention Requirements: The EEE Parts Management and Implementation Plan shall define all EEE parts data retention requirements. Data retention requirements shall as a minimum be required for:

- a. Non-Standard Parts Requests
- b. EEE Part Specifications
- c. Qualification Reports
- d. Audit and Survey Reports
- e. Destructive Physical Analysis (DPA)
- f. EEE Parts Stress Analysis and Application Reviews
- g. Ionizing Radiation test plans, procedures and reports
- h. EEE Parts lists
- g. Data used to evaluate COTS/OTS Hardware

13.4 **FORMAI**: Electronic format per Section J-2 2 3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-028
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** As-Built EEE Parts List
7. **DESCRIPTION/USE:**  
The As Built EEE Parts List provides a summary of EEE Parts usage.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.9.3.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
As Built EEE Parts List shall list the EEE parts included in completed qualification and flight hardware units and assemblies.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The report identifies EEE parts used in CEV Spacecraft flight equipment.  
The contents of the report shall include:  
  
Identification of parts by generic part name and type  
Common designation  
Specification control drawing  
Manufacturers cage code or name  
Manufacturer's part number  
Lot Date Code or Unique Lot Identifier  
Applicable NSPAR and Qualification record list  
Radiation classification  
Quantity used per application  
Next higher assembly part number
- 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.
- 13.5 **MAINTENANCE:** Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

1 **PROGRAM:** CEV 2 **DRD NO.:** CEV-T-029  
3 **DATA TYPE:** 1 4 **DATE REVISED:** 12/20/2005  
5 **PAGE:** 1

6 **TITLE:** Interface Control Documents

7 **DESCRIPTION/USE:**  
To provide documentation in the form of drawings and/or written records to identify for each side of an interface those necessary design definitions between one or more systems, modules, subsystems, computer software configuration items (CSCI's), manual operations, contractors and/or Government agencies to provide control of and ensure an agreeable and compatible interface. The Interface Control Document (ICD) provides the design solutions to the requirements found in the system specifications and/or the Interface Requirements Document (IRD); these companion documents serve to communicate and control interface design decisions.

8 **DISTRIBUTION:** As determined by the Contracting Officer.

9 **INITIAL SUBMISSION:** Per Data Requirements Matrix

10 **SUBMISSION FREQUENCY:** Per Data Requirements Matrix

11 **REMARKS:**  
The following document(s) may be used as guidance:  
• IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207; 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data

12 **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.2.1, 2.2.2.  
Referenced from SOW Paragraph(s): 6.1.2, 6.2.1.1, 9.2  
Related DRD(s): CEV-O-008, CEV-T-035

13 **DATA PREPARATION INFORMATION:**

13.1 **SCOPE:**  
The Interface Control Documents (ICD's) identify design definitions for each side of an interface that shall ensure design control and compatibility. An ICD may describe any number of software interfaces.

13.2 **APPLICABLE DOCUMENTS:**  
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)

13.3 **CONTENTS:**  
The Interface Control Document (ICD) shall document the physical, functional, and procedural interface design. The ICD shall provide the descriptive text and diagrams to fully describe the interface implementation. The ICD shall address all of the engineering disciplines associated with the interface design. The ICD shall identify all applicable workmanship and applicable standards being utilized as part of the interface design. The ICD shall provide traceability from the Interface Requirements Document (IRD) to document design compliance with the requirements.

The ICD shall address the following class of interfaces:

- (a) Physical - Interfaces involving physical mating and spatial relationships between interconnecting parts of interfacing end items, including clearance envelopes established to avoid interferences and to permit access.
- (b) Functional - Interfaces involving the interaction or influence of conditions imposed by one subsystem or component upon another or by external sources such as fluids, thermal, electrical, environmental, data, and loads.
- (c) Procedural - Interfaces involving critical sequence of events occurring in assembly, disassembly, alignment, service operations, and computer programs

For software, in accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as guidance, the ICD shall include:

- (d) Priority assigned to the interface by the interfacing entity(ies).
- (e) Type of interface (e.g., real-time data transfer, storage-and-retrieval of data) to be implemented.
- (f) Specification of individual data elements, format, and data content including bit-level descriptions of data interface that the interfacing entity(ies) will provide, store, send, access, receive.
- (g) Specification of data element assemblies, format, and data content including bit-level descriptions of data interface that the interfacing entity(ies) will provide, store, send, access, receive.
- (h) Specification of communication methods that the interfacing entity(ies) will use for the interface.
- (i) Specification of protocols the interfacing entity(ies) will use for the interface.
- (j) Other specifications, such as physical compatibility of the interfacing entity(ies).
- (k) Traceability from each interfacing entity to the system or CSCI requirements addressed by the entity's interface design, and traceability from each system or CSCI requirement that affects an interface.
- (l) Interface compatibility, e.g., little endian vs. big endian.

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE:** Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified

**DATA REQUIREMENTS DESCRIPTION (DRD)**

- 1     **PROGRAM:** CEV
- 2     **DRD NO.:** CEV-T-030
- 3     **DATA TYPE:** 2
- 4     **DATE REVISED:** 12/5/2005
- 5     **PAGE:** 1
- 6     **TITLE:** CEV/Constellation Integrated Assessment Document
- 7     **DESCRIPTION/USE:**  
This deliverable provides a summary of the findings for each Constellation Program integration analysis cycle and giving key data backing up those findings. It is used to archive the rationale for decisions made in the program and for management briefings. To verify the integrated system performance of the CEV Spacecraft in conjunction with the other Constellation systems through analysis of the spacecraft subsystems in the relevant design environments.
- 8     **DISTRIBUTION:** As determined by the Contracting Officer.
- 9     **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10    **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11    **REMARKS:**
- 12    **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.2.1.
- 13    **DATA PREPARATION INFORMATION:**
- 13.1   **SCOPE:**  
The CEV/Constellation Integrated Assessment Document will document the results of each Constellation Integration Review Assessment.
- 13.2   **APPLICABLE DOCUMENTS:**
- 13.3   **CONTENTS:**  
The CEV/Constellation Integrated Assessment Document shall document the results of the following typical integration review assessments:
  - a. Design Feasibility and Effectiveness to document integrated performance, interface and interoperability, resource management, design and decision rationale
  - b. Design Compliance Assessment to document assessment results for the integrated design's capability to meet the ESMD requirements.
  - c. Operability Assessment to document assessment results of vehicle and mission/ground support facilities can be operated as intended to prepare and execute the missions for each block.
  - d. Supportability Assessment to document assessment results that evaluated on-orbit and ground support capabilities including maintenance and repair, logistics support, stowage, EVA/Robotics support, special equipment and tools, sparring, special transportation, and technical data and documentation.
  - e. Human Rating & Crew Survival Assessment to document assessment results of the progress toward human rating the spacecraft and the integrated assessment of crew survival.
  - f. Utilization/Science Assessment to document assessment results of the review of the science needs per mission and the resource support needs (including crew time).
  - g. Integrated Risk Assessment to document assessment results of progress towards mitigating multi-element risks and ensure implementation plans

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in-place. Documents results of a systematic assessment of all requirements to ensure all risks have been identified and managed

h. Safety, Reliability, & Mission Assurance Assessment to document assessment results of integrated spacecraft failure modes and effects, critical items and hazards, reliability and maintainability, and integrated spacecraft/system health including fault detection, isolation, and recovery capabilities.

i. Launch Processing Assessment to document assessment results of readiness of the launch sites to process and launch each element.

j. Design Fidelity to document assessment results of the design maturity and data available with respect to expected/planned maturity to successfully accomplish each block variant's first launch and subsequent launches. The design fidelity assessment will analyze the product availability from each developer and report metrics on the planned versus actual for the availability and maturity.

k. Verification Assessment to document assessment results that the design complies with specifications and provides an assessment of the verification plans/requirements, integration and verification implementation plans, and current verification status.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.





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13.3 **CONTENTS:**

The system requirements specifications shall allocate the CEV System functional, performance and operational requirements and constraints to define the design and architecture of the total System, including software, between the Spacecraft and Ground Systems. Two (2) documents shall be produced comprising the next level of decomposition from the CEV System level requirements. The requirements shall be allocated between Spacecraft and Ground Support Equipment.

The module requirements specifications shall decompose the CEV spacecraft system functional, performance, and operational requirements to the module level. A module is defined as a self-contained unit of a spacecraft that performs a specific task or class of tasks in support of the major function of the craft. For example, a spacecraft may be broken up into a crew module, a service module, etc.

The subsystem requirements specifications shall decompose the CEV module functional, performance, constraints and design requirements to define the design and architecture of the total subsystem, including software.

The component requirements specifications shall contain the decomposition of the requirements from the subsystem level through the lowest level of the decomposition. This specification will document the allocated functional, performance, constraints and design requirements for the CEV subsystem to the component level. For the purposes of this DRD, 'component' will be used to describe each level of the decomposition below the subsystem level as defined by the Contractor. The decomposition of the subsystem is continued until a procurement or build-to specification has been developed. A component is defined as an aggregate of hardware and/or software that can be characterized by one specification, is designed by a single activity to be functionally tested, and is verified as a unit.

Each document shall contain a section titled 'Verification'. For each requirement in the documents, there shall be a corresponding verification requirement. The document shall contain, in addition to the verification requirements, a verification traceability matrix that establishes the relationship between each requirement and its verification requirements, and contains the methods that will be used to accomplish the indicated verification actions.

- 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1. As required by ICE, the Contractor shall also include this data in a requirements management tool for easy data entry.

- 13.5 **MAINTENANCE:** Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-032
3. **DATA TYPE:** 1
4. **DATE REVISED:** 12/5/2005
5. **PAGE:** 1
6. **TITLE:** CEV Specification and Drawing Trees
7. **DESCRIPTION/USE:**

A specification tree is a hierarchical breakdown (i.e., parent, child, etc.) of the specification documents interrelationships, as applicable, to the contract configuration items beginning with the highest system/product assembly level to be delivered with subsequent breakdown of lower-tiered subordinate requirements documents.

A drawing tree is a hierarchical breakdown of the engineering drawings that define the system/product to be delivered beginning with the highest assembly level with subsequent breakdown of lowered-tiered drawings. Collectively they define the complete engineering configuration of the system/product to be delivered.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.3.
13. **DATA PREPARATION INFORMATION:**
  - 13.1 **SCOPE:**

CEV Specification and Drawing Trees depict the hardware and software configuration items in top down, or hierarchical breakdown form.
  - 13.2 **APPLICABLE DOCUMENTS:**
  - 13.3 **CONTENTS:**

The specification and drawing trees shall consist of an indentured or generation breakdown listing of all specification documents or drawings applicable to a configuration item.
  - 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.
  - 13.5 **MAINTENANCE:** Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

1 PROGRAM: CEV  
2 DRD NO.: CEV-T-033  
3 DATA TYPE: 2  
4 DATE REVISED: 12/21/2005  
5 PAGE: 1

6 TITLE: Architecture Design Document

7 DESCRIPTION/USE:  
To describe the functional design of CEV and its operational and support environments. To identify an appropriate set of resources to satisfy a system need, and the requirements for those resources that provide a sound basis for their design or selection. To describe the organization of a CEV as composed of hardware configuration items (HWCI's), computer software configuration items (CSCI's), CSCI groupings, and manual operations. To describe how the functional design and the HWCI's, SWCI's, and interfaces between them comprise an architecture consistent with a modular open systems approach.

8 DISTRIBUTION: As determined by the Contracting Officer.

9 INITIAL SUBMISSION: Per Data Requirements Matrix

10 SUBMISSION FREQUENCY: Per Data Requirements Matrix

11 REMARKS:  
Information provided in other DRD's is anticipated to be used in the preparation of data items in response to this DRD. This information may be included by reference in this data item. The Architecture Design Document provides the functional decomposition of the system and the rationale corresponding to the traceability of system requirements to their lowest level.

12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 2.3.  
Referenced from SOW Paragraph(s): 2.1.3, 6.2

13 DATA PREPARATION INFORMATION:

13.1 SCOPE:  
In the early development phase, through completion of preliminary design work, the systems engineering activity focuses on identification of the technical requirements for the system that define what the modules, subsystems, and components must do and how well they must do it. During the detailed design phase the systems engineering activity emphasis switches to identification of requirements for the acceptance of the physical product elements by the Constellation Program and logistics requirements.

The Architecture Design Document provides the functional design and associated design rationale for the system's requirements that shall ensure proper testability and performance over the entire range of operations.

13.2 APPLICABLE DOCUMENTS:

13.3 CONTENTS:  
The Architecture Design Document shall contain:  
a. Scope. This section shall be divided into the following paragraphs:  
1. Identification. This paragraph shall contain a full

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identification of the CEV System to which this document applies, including, as applicable, identification number(s), title(s), abbreviation(s), version number(s), and release number(s).

2. Architecture overview. This paragraph shall briefly state the purpose of the CEV System. It shall describe the general nature of the CEV System; summarize the history of CEV System development, operation, and maintenance; identify the project sponsor, acquirer, user, developer, and support agencies; identify current and planned operating sites; and list other relevant documents.

3. Document overview. This paragraph shall summarize the purpose and contents of this document and shall describe any security or privacy considerations associated with its use.

b. Referenced documents. This section shall list the number, title, revision, and date of all documents referenced in this document. This section shall also identify the source for all documents not available through normal NASA stocking activities.

c. Systemwide design decisions. This section shall be divided into paragraphs as needed to present systemwide design decisions, that is, decisions about the system's behavioral design (how it will behave, from a user's point of view, in meeting its requirements, ignoring internal implementation) and other decisions affecting the selection and design of system components. If all such decisions are explicit in the requirements or are deferred to the design of the system components, this section shall so state. Design decisions that respond to requirements designated critical, such as those for safety, security, or privacy, shall be placed in separate subparagraphs. If a design decision depends upon system states or modes, this dependency shall be indicated. Design conventions needed to understand the design shall be presented or referenced.

d. Requirements Analysis. This section shall address the associated requirements based analysis and focuses on the activities of requirements analysis, functional analysis, requirements allocation, and design constraints analysis. The requirements analysis process shall be initially top down and evolutionary in nature, leading from definition at the CEV System level, to the subsystem level, and to major components of the CEV System. Specific areas to be addressed are:

1. Mission & Operational Analysis.

2. Functional Analysis and Allocation.

(a) Functional flow block diagrams.

(b) Requirements allocation sheets.

(c) Mission timeline.

3. Requirements Analysis.

(a) Performance requirements analysis.

(b) Performance requirements allocation.

(c) Performance attributes

(d) Specialty engineering requirements analysis

(maintainability, reliability, human factors and safety, producibility, affordability, supportability, etc.).

4. Constraints Analysis.

(a) Physical (fit, form, durability, etc.).

(b) Environmental.

(c) Interfaces (physical & functional).

(d) Operational and logistics.

(e) Design.

(f) Cost.

(g) Schedule.

(h) Technology.

5. Decision Support Data - Documentation of system engineering studies on functional and performance requirements.

Provide any models, simulations, or tools required as appropriate that was used to perform the analysis.

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e. System architectural design. This section shall be divided into the following paragraphs to describe the CEV System architectural design. If part or all of the design depends upon CEV System states or modes, this dependency shall be indicated. If design information falls into more than one paragraph, it may be presented once and referenced from the other paragraphs. Design conventions needed to understand the design shall be presented or referenced.

NOTE: For brevity, this section is written in terms of organizing a system directly into Hardware Configuration Items (HWCIs), Computer Software Configuration Items (CSCIs), and manual operations, but shall be interpreted to cover organizing a system into subsystems, organizing a subsystem into HWCIs, CSCIs, and manual operations, or other variations as appropriate.

1. System components. This paragraph shall:

(a) Identify the components of the system (HWCIs, CSCIs, and manual operations). Each component shall be assigned a project-unique identifier. Note: a database may be treated as a CSCI or as part of a CSCI.

(b) Show the static (such as 'consists of') relationship(s) of the components. Multiple relationships may be presented, depending on the selected design methodology.

(c) State the purpose of each component and identify the System requirements and systemwide design decisions allocated to it. Alternatively, the allocation of requirements may be provided in 15.3e(1).

(d) Identify each component's development status/type, if known (such as new development, existing component to be reused as is, existing design to be reused as is, existing design or component to be reengineered, component to be developed for reuse, component planned for Build N, etc.) For existing design or components, the description shall provide identifying information, such as name, version, documentation references, location, etc.

(e) For each computer system or other aggregate of computer hardware resources identified for use in the System, describe its computer hardware resources (such as processors, memory, input/output devices, auxiliary storage, and communications/ network equipment). Each description shall, as applicable, identify the configuration items that will use the resource, describe the allocation of resource utilization with associated margin to each CSCI that will use the resource (for example, 20% of the resource's capacity allocated to CSCI 1, 30% to CSCI 2), describe the conditions under which utilization will be measured, and describe the characteristics of the resource.

2. Concept of execution. This paragraph shall describe the concept of execution among the system components. It shall include diagrams and descriptions showing the dynamic relationship of the components, that is, how they will interact during System operation, including, as applicable, flow of execution control, data flow, dynamically controlled sequencing, state transition diagrams, timing diagrams, priorities among components, handling of interrupts, timing/sequencing relationships, exception handling, concurrent execution, dynamic allocation/deallocation, dynamic creation/deletion of objects, processes, tasks, and other aspects of dynamic behavior.

3. Interface design. This paragraph shall be divided into the following subparagraphs to describe the interface characteristics of the system components. It shall include both interfaces among the components and their interfaces with external entities such as other systems, configuration items, and users. Note: There is no requirement for these interfaces to be completely designed at this level; this paragraph is provided to allow the recording of interface design decisions made as part of system architectural design. If part or all of this information

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is contained elsewhere, these sources may be referenced.

(a) Interface identification and diagrams. This paragraph shall state the project-unique identifier assigned to each interface and shall identify the interfacing entities (systems, configuration items, users, etc.) by name, number, version, and documentation references, as applicable. The identification shall state which entities have fixed interface characteristics (and therefore impose interface requirements on interfacing entities) and which are being developed or modified (thus having interface requirements imposed on them). One or more interface diagrams shall be provided, as appropriate, to depict the interfaces.

(b) Project-unique identifier of interface. This paragraph shall identify an interface by project-unique identifier, shall briefly identify the interfacing entities, and shall be divided into subparagraphs as needed to describe the interface characteristics of one or both of the interfacing entities. If a given interfacing entity is not covered by this ADD (for example, an external system) but its interface characteristics need to be mentioned to describe interfacing entities that are, these characteristics shall be stated as assumptions or as 'When [the entity not covered] does this, [the entity that is covered] will ....' This paragraph may reference other documents (such as data dictionaries, standards for protocols, and standards for user interfaces) in place of stating the information here. The design description shall include the following, as applicable, presented in any order suited to the information to be provided, and shall note any differences in these characteristics from the point of view of the interfacing entities (such as different expectations about the size, frequency, or other characteristics of data elements):

(1) Priority assigned to the interface by the interfacing entity(ies).

(2) Type of interface (such as real-time data transfer, storage-and-retrieval of data, etc.) to be implemented.

(3) Characteristics of individual data elements that the interfacing entity(ies) will provide, store, send, access, receive, etc. (e.g., identifiers, data type, size, format, range, accuracy, etc.).

(4) Characteristics of data element assemblies (records, messages, files, arrays, displays, reports, etc.) that the interfacing entity(ies) will provide, store, send, access, receive, etc. (e.g., identifiers, data elements, medium, visual and auditory characteristics, etc.).

(5) Characteristics of communication methods that the interfacing entity(ies) will use for the interface (e.g., identifiers, links/bands, formatting, transfer rates, etc.).

(6) Characteristics of protocols that the interfacing entity(ies) will use for the interface (e.g., identifiers, priority/layer, error control, packeting, synchronization, etc.).

(7) Other characteristics, such as physical compatibility of the interfacing entity(ies) (dimensions, tolerances, loads, voltages, plug compatibility, etc.).

f. Requirements traceability. This paragraph shall contain (if information is contained in Requirements Traceability Matrix, or elsewhere, it may be referenced):

1. Traceability from each system component identified in this Architecture Definition Document to the system requirements allocated to it.

2. Traceability from each system requirement to the System components to which it is allocated.

3. Traceability from design decision data to the requirements to support validation of the requirements

g. Notes. This section shall contain any general information that aids in understanding this document (e.g., background information, glossary, rationale). This section shall contain an alphabetical listing of all acronyms, abbreviations, and their meanings as used in this document and a list of any terms and definitions needed to understand this document.

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- h. Appendices. Appendices may be used to provide information published separately for convenience in document maintenance (e.g., charts, classified data). As applicable, each appendix shall be referenced in the main body of the document where the data would normally have been provided. Appendices may be bound as separate documents for ease in handling. Appendices shall be lettered alphabetically (A, B, etc.).
- 13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1 Requirements traceability (including decision support and requirements validation data) must be maintained within the requirements database.
- 13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required

## DATA REQUIREMENTS DESCRIPTION (DRD)

- 1 **PROGRAM:** CEV 2. **DRD NO.:** CEV-T-034  
3. **DATA TYPE:** 1 4. **DATE REVISED:** 12/19/2005  
5 **PAGE:** 1  
6. **TITLE:** Requirements Traceability Report  
7 **DESCRIPTION/USE:**  
To ensure traceability and visibility that program/project requirements and that they have been completely and properly flowed down to appropriate lower level requirements documents.  
8 **DISTRIBUTION:** As determined by the Contracting Officer.  
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix  
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix  
11 **REMARKS:**  
12 **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.3.  
Referenced from SOW Paragraph(s): 6.2  
13 **DATA PREPARATION INFORMATION:**  
13.1 **SCOPE:**  
The Requirements Traceability Report documents the flow down of requirements starting with the CEV System requirements down through subsequent levels as determined by the Specification Tree.  
13.2 **APPLICABLE DOCUMENTS:**  
CXP-10001: Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD)  
13.3 **CONTENTS:**  
The Requirements Traceability Report shall identify and and provide bi-directional traceability for all CEV Project requirements from the CEV System requirements to subsystem and lower level requirements as documented in the Specification Tree. Traceability must be established for all requirements sources. The report shall be produced from the requirements database as part of the Contractor's system engineering tool. The report shall state the paragraph numbers and requirements to be met at each level. Higher-level requirements that are not flowed down and lower level requirements that do not trace to a higher-level requirement shall be identified.  
13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1  
13.5 **MAINTENANCE:** Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.



## DATA REQUIREMENTS DESCRIPTION (DRD)

- 1 PROGRAM: CEV 2. DRD NO.: CEV-T-035  
3. DATA TYPE: 1 4 DATE REVISED: 12/6/2005  
5 PAGE: 1  
6 TITLE: Internal Interface Requirements Document (IRD)  
7 DESCRIPTION/USE:  
To specify the interface requirements between each module, between each subsystem, and between Computer Software Configuration Items (CSCIs). Also to specify requirements imposed upon or by manual operations, or other system components to achieve one or more interfaces among the modules, subsystems, and CSCIs. To be used in conjunction with the Software Requirements Specification as a basis for design and qualification testing of software systems and CSCIs.  
8 DISTRIBUTION: As determined by the Contracting Officer.  
9 INITIAL SUBMISSION: Per Data Requirements Matrix  
10 SUBMISSION FREQUENCY: Per Data Requirements Matrix  
11 REMARKS:  
The following document(s) may be used as guidance:  
• IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207; 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data  
12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 6.1.1.  
Referenced from SOW Paragraph(s): 6.2.7, 9.2  
Related DRD(s): CEV-O-008, CEV-T-029, CEV-T-048  
13 DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
The Internal Interface Requirements Document (IRD) shall contain the interface requirements between each of the CEV modules, subsystems, and CSCI interfaces within the spacecraft. This specification also details provisions for qualification and requirements traceability. An IRD shall be produced for each CSCI that interfaces to another CSCI and for each CSCI that interfaces directly to a hardware component. The corresponding interface verification requirements for the IRDs will be contained in the applicable Interface Control Document (ICD).  
13.2 APPLICABLE DOCUMENTS:  
13.3 CONTENTS:  
The Internal Interface Requirements Document (IRD) shall define all physical, functional and procedural interface requirements to ensure system, hardware, and software compatibility. The IRDs shall include the following:  
a. Physical - Interface requirements involving physical mating and spatial relationships between interconnecting parts of interfacing end items, including clearance envelopes established to avoid interferences and to permit access.  
b. Functional - Interfaces involving the interaction or influence of conditions imposed by one subsystem or component upon another or by external sources such as fluids, thermal, electrical, environmental,

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data, and loads.

c. Procedural - Interfaces involving critical sequence of events occurring in assembly, disassembly, alignment, service operations, and computer programs.

For software, using IEEE/EIA 12207.1-1997 as guidance, IRD shall include:

d. Requirements imposed on one or more systems, subsystems, configuration items, manual operations or other system components to achieve one or more software interfaces among these entities.

1. Interface identification and diagrams.

2. Project-unique identifier of interface.

3. Precedence and criticality of requirements.

e. Qualification provisions.

f. Requirements traceability

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1. As required by ICE, the Contractor shall also include this data in a requirements management tool for easy data entry.

13.5 **MAINTENANCE:** Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified.

## DATA REQUIREMENTS DESCRIPTION (DRD)

1 PROGRAM: CEV 2 DRD NO.: CEV-T-036  
3 DATA TYPE: 2/3\* 4 DATE REVISED: 12/5/2005  
5 PAGE: 1  
6 TITLE: Margins Management Plan/Report

7 DESCRIPTION/USE:  
The Margins Management Plan is the unified system level approach to margin/contingency control. It defines the system design resources, their budgets, subsystem allocations, and current properties. The Margins Management Report includes resource properties reports for all managed design resources (e.g., volume report, mass properties report, electrical power and energy properties report, thermal properties report, etc.).

8 DISTRIBUTION: As determined by the Contracting Officer.

9 INITIAL SUBMISSION: Per Data Requirements Matrix

10 SUBMISSION FREQUENCY: Per Data Requirements Matrix

11 REMARKS:  
The Margins Management Plan shall be Data Type 2; Margins Management Reports shall be Data Type 3.

12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 6.1.2.

13 DATA PREPARATION INFORMATION:

13.1 SCOPE:  
The Margins Management Plan is a statement of the contractor's margin management philosophy. The Margins Management Plan and Margins Management Reports provide the CEV Project with detailed identification of all resource margins and embedded margins necessary to ensure mission success and system robustness.

13.2 APPLICABLE DOCUMENTS:

13.3 CONIENTS:  
This DRD consists of two products: The Margins Management Plan and Margins Management Reports.

The CEV Margins Management Plan shall include:

- Identification of resources with margins (e.g., mass, power, bandwidth, thermal control, communications, error budgets, etc.).
- Identification of resource interdependencies and sensitivities (e.g., additional processing capability requires additional heat removal that requires additional power that in-turn increases mass).
- Identification of interfaces-related 'external' margins (e.g., Lunar Surface Access Module (LSAM), Earth Departure Stage (EDS), Crew Launch Vehicle (CLV)).
- Development of resource reallocation strategies.
- Development of resource allocations.
- Development of resource budgets.
- Plan for reporting resource best estimates and applying contingencies and margins (including disclosure of embedded margins that

can be quantified consistent with subsystem growth margins).

h. Development of monthly resource status review formats and content.

i. Development of major review resource properties/status reports formats and content.

The Margins Management Reports shall consist of the content identified in (g), (h), and (i) above.

134 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

135 **MAINTENANCE:** Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-037
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Qualification Test Procedures
7. **DESCRIPTION/USE:**  
To provide the test procedures for demonstrating that the design and performance requirements can be demonstrated for all CEV project requirements, including the range of projected environments and operating conditions anticipated over the service life.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
Qualification hardware shall have the same configuration and experience the same manufacturing processes as the flight production hardware.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.1.4.  
Related DRD(s): CEV-T-038
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Qualification Test Procedures contain the test procedures for the formal tests conducted to demonstrate that the design and manufacturing processes produce Spacecraft systems and components that conform to all CEV Project performance requirements including the range of projected environments and operating conditions anticipated over the service life. These tests demonstrate that the design and performance requirements for a Spacecraft system and component can be demonstrated under specified conditions, including stress, thermal, EEE parts, stress/de-rating, structural, off-gassing, flammability, toxicological, and others specific to the product.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The Qualification Test Procedures shall contain the following:
  1. Description of the test item
  2. Environmental requirements
  3. Test requirements
  4. Test definition
  5. Test items
  6. Test preparation requirements, including
    - a) Test readiness review
    - b) Safety and environment
    - c) Personnel and training
    - d) Facilities, equipment, and fixtures
    - e) Security
    - f) Material
    - g) Test documentation
    - h) Test recording

- 7. Equipment set-up
- 8. Test operations

134 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

135 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-038
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/5/2005
5. **PAGE:** 1
6. **TITLE:** Qualification Test Report
7. **DESCRIPTION/USE:**  
To provide the documentation that demonstrates that the product conforms to all CEV project performance requirements, including the range of projected environments and operating conditions anticipated over the service life.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
Qualification hardware shall have the same configuration and experience the same manufacturing processes as the flight production hardware
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.1.4.  
Related DRD(s): CEV-T-037
13. **DATA PREPARATION INFORMATION:**
- 13.1. **SCOPE:**  
The Qualification Test Report contains the test documentation results for the formal tests conducted to demonstrate that the design and manufacturing processes produce Spacecraft systems and components that conform to all CEV project performance requirements, including the range of projected environments and operating conditions anticipated over the service life. These reports demonstrate that the design and performance requirements for the Spacecraft system and components have been demonstrated under specified conditions, including stress, thermal, EEE parts, stress/de-rating, structural, off-gassing, flammability, toxicological, and others specific to the product.
- 13.2. **APPLICABLE DOCUMENTS:**
- 13.3. **CONTENTS:**  
A Qualification Test Report shall contain the following:
  1. Description of the test item
  2. Description of the test performed
  3. Description of the test equipment and facility
  4. Test witnesses
  5. Test set-up/configuration information
  6. Tests results
  7. Test conclusions
- 13.4. **FORMAT:** Electronic format per Section J-2 2.3.2.1.
- 13.5. **MAINTENANCE:** Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

## DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-039
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/12/2005
5. **PAGE:** 1
6. **TITLE:** Acceptance Test Procedures
7. **DESCRIPTION/USE:**  
To provide the test procedures for demonstrating that a component, CSCI, module, or system is capable of meeting performance requirements prescribed in purchase specifications or other documents specifying what constitutes the adequate performance capability for the item in question.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
Acceptance testing shall be completed on all flight components, modules, and spacecraft.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.1.4.  
Related DRD(s): CEV-T-014, CEV-T-040
13. **DATA PREPARATION INFORMATION:**
- 13.1. **SCOPE:**  
The Acceptance Test Procedures contain the test procedures for demonstrating that a component, CSCI, module, or system is capable of meeting performance requirements prescribed in purchase specifications or other documents specifying what constitutes the adequate performance capability for the item in question.
- 13.2. **APPLICABLE DOCUMENTS:**
- 13.3. **CONTENTS:**  
The Acceptance Test Procedures shall contain the following:
1. Description of the test item
  2. Test definition
  3. Test preparation requirements, including
    - a) Test readiness review
    - b) Safety and environment
    - c) Personnel and training
    - d) Facilities, equipment, and fixtures
    - e) Security
    - f) Material
    - g) Test documentation
    - h) Test recording
  4. Equipment set-up
  5. Visual inspections required
  6. Operational test requirements
  7. Environmental test requirements
  8. Final functional operating test
- 13.4. **FORMAI:** Electronic format per Section J-2 2.3.2.1.



- 13.5 MAINTENANCE: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required

## DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-040
3. **DATA TYPE:** 1
4. **DATE REVISED:** 12/5/2005
5. **PAGE:** 1
6. **TITLE:** Acceptance Data Package
7. **DESCRIPTION/USE:**  
To provide the documentation needed by NASA to establish the acceptability of integrated systems/hardware/software for their intended use.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
Acceptance tests shall demonstrate conformance to specification requirements and provide quality control assurance against workmanship or material deficiencies.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.1.4.  
Referenced from SOW Paragraph(s): 2.2.1, 2.2.2, 6.2.1.1, 6.4, 6.5, 9.2  
Related DRD(s): CEV-T-014, CEV-T-039
13. **DATA PREPARATION INFORMATION:**
- 13.1. **SCOPE:**  
The Acceptance Data Package contains the elements of documentation required to establish the acceptability of integrated systems, hardware, and software.
- 13.2. **APPLICABLE DOCUMENTS:**
- 13.3. **CONTENTS:**  
An ADP for hardware contract configuration items shall contain the current log book that includes:
  1. Running/operating time and cycle for each time and cycle critical item of the Configuration Item (CI). These logs shall identify the item(s) by nomenclature, part number, and serial number and shall state the total authorized life and the life expended.
  2. Test history log, including post manufacturing checkout and final verification tests of the CI, with the following data:
    - a. Actual measurements identified to specified tests. References to applicable test reports are satisfactory provided that copies of the reports are provided. All test data shall be made available for development and standardization of formal checkout procedures, establishment of performance trends, supporting maintenance planning, and resolution of anomalies.
    - b. Conformance to specification requirements and quality control assurance against workmanship or material deficiencies.
    - c. Brief test summary.
    - d. List of unaccomplished tasks and estimated man-hours to complete.
    - e. List of actual and recommended retest.
    - f. Special test instructions, investigations, warnings, and

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problems encountered during test.

g. Failure and corrective actions data for all failures during all testing.

3. Inspection records for all inspections.

4. Transfer records providing a history of all CI and critical component movements.

5. Alignment data for all CIs and critical items.

6. Component logbook, including Government furnished items.

7. Weight and balance logs covering total weight and horizontal, vertical, and lateral center(s) of gravity.

8. Configuration Records:

a. Parts and drawing list identifying all parts and incorporated or pending changes to each.

b. Software configuration records defining the verified and validated software, version description documents, software certification, and the validated software program.

c. List of approved and pending deviations and waivers.

d. Complete list of hardware and software/firmware items shipped loose or separately.

e. Copy of proposed DD Form 250.

9. Accumulated component time and/or cycles at time of shipment.

The Software Acceptance Data Package shall include:

1. Summary and status of all accepted Change Requests (CRs) to the baselined Software Requirements Specifications (SRS(s)).

2. Summary and status of all major software capability changes since baselining of the Software Design Documents (SDD(s)).

3. Summary and status of all major software tests (including development, verification, and performance testing).

4. Summary and status of all discrepancy reports written against the software.

5. Summary and status of all software requirements deviations and waivers.

6. Summary and status of all software user notes.

7. Summary and status of all quality metrics historically and for this software.

8. Definition of open work, if any.

9. Software configuration records defining the verified and validated software, including the final Software Version Description (SVD) for this software.

10. Copy of proposed DD Form 250.

An integrated Acceptance Data Package shall include:

1. Hardware Acceptance Data Package(s).

2. Software Acceptance Data Package(s).

3. Additional integration test results.

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2 1.

13.5 **MAINTENANCE:** Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-041
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/6/2005
5. **PAGE:** 1
6. **TITLE:** CEV Instrumentation Plan
7. **DESCRIPTION/USE:**  
This DRD develops and records the plans and processes for all instrumentation development and implementation activities.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.1.5.2.  
Related DRD(s): CEV-T-047
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The instrumentation plan provides insight into, and a tool for monitoring, the processes to be followed for CEV spacecraft instrumentation development and implementation activities. This DRD will include the provisions for the calibration of the instrumentation transducers and sensors to assure end-to-end error and tolerances are within required performance. All technical information related to the instrumentation requirements allocation, trade studies, system analysis, design, test, verification, certification and sustaining engineering shall be documented in DRD-T-047, Avionics Design and Data Book Volume II - Command and Data Handling/Instrumentation Subsystem Data.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The CEV Instrumentation Plan shall include the following processes and plans:
  - a. A process that identifies and allocates instrumentation and sensor requirements across the CEV System including subsystem engineering and operational needs. The process shall include the roles and responsibilities for sensors interface design and the approval of the subsystem sensor requirements definition, procurement and testing, and the definition and provisioning for the calibration of the instrumentation transducers and sensors to assure end-to-end error and tolerances are within required performance.
  - b. A development process that addresses: long lead parts procurement, potential obsolescence issues, determination of required trade studies, prototyping approach and development test, modeling, and analysis aimed at reducing technical risks.
  - c. A plan that addresses the necessary facilities and equipment for developing and certifying the CEV instrumentation across the vehicle system and within each subsystem.
  - d. A ground data reduction process and the hardware/software required to

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support this capability

e. A metrics plan to measure key aspects of these processes.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word-compatible.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required, with changes clearly identified.

## DATA REQUIREMENTS DESCRIPTION (DRD)

- |    |                     |    |                                |
|----|---------------------|----|--------------------------------|
| 1. | <b>PROGRAM:</b> CEV | 2  | <b>DRD NO.:</b> CEV-T-042      |
| 3  | <b>DATA TYPE:</b> 2 | 4. | <b>DATE REVISED:</b> 12/5/2005 |
|    |                     | 5. | <b>PAGE:</b> 1                 |
- 6 **TITLE:** Mass Properties Control Plan
7. **DESCRIPTION/USE:**  
The Mass Properties Control Plan defines the processes for the collection, processing, reporting and control of CEV mass properties information. NASA will utilize the contractor's Mass Properties Control Plan to ensure that the contractor's mass properties management and control process is acceptable for the accomplishment of CEV Project objectives.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6 1.5.3.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Mass Properties Control Plan defines the contractor's mass properties organizational structure and the associated processes for the acquisition, reduction, control and reporting of mass properties data throughout the CEV life cycle. The Mass Properties Control Plan also covers the definition of target mass, reserve mass and growth allocations as well as the reconciliation of mass estimates with measured data from as-built hardware.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The Mass Properties Control Plan shall include the following:  
a) Definition of the contractor's mass properties organizational structure  
b) Definition of the contractor's data preparation process and data flow from discipline organizations through management  
c) Definition of the contractor's process in establishing mass allocations, reporting requirements and verification requirements including subcontractor and vendor hardware  
d) Definition of the contractor's process for mass properties trend analysis, variance tracking and risk assessment  
e) Definition of the gross, inert, dry and sequential mass properties control process including:  
1. Mass property report format including functional breakdown  
2. Data acquisition and reduction methodology for the entire CEV life cycle  
3. Change procedures  
4. Data uncertainties with respect to the source and maturity of the mass property data  
5. Data accuracy anticipated at major program milestones

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- f) Contractor mass target and reserve approach
- g) Identification of mass properties limits
- h) Mass growth plan including growth allocations and the process for growth depletion with respect to the maturation of the basic CEV System mass

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE:** Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of this document is required with changes clearly identified.

## DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-043
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/5/2005
5. **PAGE:** 1
6. **TITLE:** Mass Properties Reports
7. **DESCRIPTION/USE:**  
Mass Properties Reports provide a status on the contractor's CEV System mass properties including allocated and non-allocated growth. NASA will employ the Mass Properties Report to track contractor variance from CEV System mass properties targets as well as to support requirements development, technical analyses and trade studies for the CEV spacecraft and mated Constellation element configurations.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.1.5.3.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
Periodic mass properties reports provide insight into the status of the CEV System mass properties throughout all program phases. The basis (estimated, calculated or measured) of each component mass shall be included as part of the recorded component data. Totals of the estimated, calculated and measured mass properties data shall be recorded to provide an indication of the mass properties confidence
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The Mass Properties Reports shall include the following:
- a) Dry Mass Properties
    1. Mass summary (last, current, contract end item, maturity level in percent)
    2. Comprehensive reasons for changes since the previous mass properties status report
    3. List of pending and potential changes
    4. Mass properties summary including mass moments and products of inertia (subsystem, element, sequential)
    5. Mass history plot
    6. Status of current and projected mass versus control mass
    7. CEV mass properties coordinate system description including offsets from other Constellation coordinate systems
    8. Detailed mass properties reflecting the current database in sufficient detail to reflect major items and subsystems
    9. Summary performance margins
    10. References, if applicable
    11. Critical mass properties status
    12. Government Furnished Equipment (GFE)



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b) Sequential Mass Properties as a function of time and mission event, as appropriate

1. Gross liftoff mass, summarized by dry, inert and expendables
2. Nominal ascent
3. On-orbit
4. Nominal re-entry

13.4 **FORMAT**: Electronic format per Section J-2 2 3.2.1. Mass properties reports provided in Microsoft® Word-compatible format with spreadsheet data supplied in Microsoft® Excel®-compatible format. NASA access to native contractor mass properties database or formatted database export file upon request.

13.5 **MAINTENANCE**: Changes to this document shall be incorporated by complete re-issue of the report.

1 PROGRAM: CEV 2 DRD NO.: CEV-T-044  
3 DATA TYPE: 2 4 DATE REVISED: 12/19/2005  
5 PAGE: 1

6 TITLE: CEV MMOD Analysis Report

7 DESCRIPTION/USE:  
Micrometeoroid and Orbital Debris (MMOD) analysis involves the assessment of risk to the spacecraft and crew resulting from damage or penetration from micrometeoroid and orbital debris impacts during various mission phases. MMOD Analyses will provide feedback verification that the CEV flight system design meets protection requirements specified by the CEV Project.

8 DISTRIBUTION: As determined by the Contracting Officer.

9 INITIAL SUBMISSION: Per Data Requirements Matrix

10 SUBMISSION FREQUENCY: Per Data Requirements Matrix

11 REMARKS:  
This is a requirement to assess MMOD damage to CEV TPS and/or other vehicle hardware that leads to loss of vehicle or crew on-orbit or during reentry using Bumper code or equivalent MMOD risk assessment software.

12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 6.1.5.4.

13 DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
This document will be used to ensure that all CEV flight system designs meet MMOD protection requirements.

13.2 APPLICABLE DOCUMENTS:  
CXP-00102: Constellation Design Specification for Natural Environments (DSNE) (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)  
CXP-05000: Constellation Program Natural Environment Definition for Design (NEDD)  
JPR 8080.5, M/S-11: JSC Design and Procedural Standards, Section M/S-11, Meteoroid and Orbital Debris Protection Levels for Structures  
NASA TP-2003-210788: Meteoroid/Debris Shielding, 2003, Section 2 for describing the MMOD risk assessment process using Bumper code

13.3 CONTENTS:  
MMOD analysis reports shall include:  
a. Baseline assessments of the MMOD risk (overall and by mission phase) to the CEV for loss of mission and loss of crew based on the design MMOD environments derived from CXP-00102, Constellation Design Specification for Natural Environments (DSNE) (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List), utilizing CXP-05000, Constellation Program Natural Environment Definition for Design (NEDD). The baseline assessments will be updated as the CEV design evolves.  
b. Focused MMOD impact assessments for safety-critical components and subsystems such as the thermal protection system, radiators and other fluid systems, pressure vessels and windows, and safety-critical

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mechanisms

- c. Supplemental MMOD analyses to define the sensitivities of the baseline results to orbital altitude, spacecraft attitude, duration of exposure, and uncertainties or projected growth in the MMOD environment.
- d. Evaluation of the baseline results to support CEV design optimization with respect to competing design priorities and constraints.
- e. Evaluation of supplemental or alternate MMOD shielding approaches, as appropriate.
- f. Description of all CEV MMOD analysis models and tools including calibration results against accepted standards. This description includes all risk assessment assumptions and inputs, MMOD protection configurations used in the risk assessments, failure criteria as appropriate for loss of vehicle/crew and loss of mission from the MMOD environment, ballistic limit equations and available impact test data supporting the equations.
- g. Document all vehicle design, system and operational considerations implemented to meet MMOD protection requirements during CEV System risk allocation.

- 13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® or Adobe® Acrobat® PDF for textual and graphics information, ASCII delimited for data, and XML
- 13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

## DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-045
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/19/2005
5. **PAGE:** 1
6. **TITLE:** CEV Space Radiation Analysis and Certification Report
7. **DESCRIPTION/USE:**

Radiation Analyses will be used to describe the internal CEV radiation environments that result from exposure to nominal space radiation environments and enhanced solar particle events. This analysis will be used by NASA to ensure that radiation exposure to astronaut crews is kept as low as reasonably achievable (ALARA).
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.1.5.5.
13. **DATA PREPARATION INFORMATION:**
- 13.1. **SCOPE:**

The contractor shall provide NASA with with radiation analyses that describes the projected radiation environment present based on the vehicle design.
- 13.2. **APPLICABLE DOCUMENTS:**

CXP-00102: Constellation Design Specification for Natural Environments (DSNE) (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)  
CXP-01000, Section 3.7: Constellation Human System Integration Requirements (HSIR), Section 3.7  
CXP-05000: Constellation Program Natural Environment Definition for Design (NEDD)  
National Council on Radiation Protection and Measurements Report No. 132:  
National Council on Radiation Protection and Measurements Report No. 132:  
Radiation Protection Guidance for Activities in Low-Earth Orbit  
National Council on Radiation Protection and Measurements Report No. TBD:  
Radiation Protection and Science Goals for Lunar Missions (to be published in 2006)  
OSHA Standards 29 CFR: Supplementary Standards 1960.18
- 13.3. **CONIENTS:**

The Space Radiation Analysis and Certification Report shall use the space radiation environments described in the CXP-00102, Constellation Design Specification for Natural Environments (DSNE) (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List), utilizing CXP-05000, Constellation Program Natural Environment Definition for Design (NEDD), and determine the doses internal to the CEV habitable area during enhanced space weather conditions (significant solar particle events), and nominal solar maximum and solar minimum conditions.

The Space Radiation Analysis and Certification Report shall detail the following:

- Radiation analysis performed including structural models, materials selection, stowage planning (including worst case scenarios where the plan is not followed), and design decisions.
- Transport models
- Human models

- 134 **FORMAT**: Electronic format per Section J-2 2.3.2.1. Microsoft® Word/Excel® or Adobe® Acrobat® PDF for textual and graphics information, or ASCII delimited for data.
- 135 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

## DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-046
3. **DATA TYPE:** 1
4. **DATE REVISED:** 12/5/2005
5. **PAGE:** 1
6. **TITLE:** CEV Data and Command Dictionary
7. **DESCRIPTION/USE:**  
Used to define, manage, and record all data elements that interface with the core avionics software and hardware, the subsystem specific software, and the ground systems. Specific data elements include: end-to-end channelization information, calibration information, sensor range, telemetry formats, and command information required to define the entire software system/architecture. This DRD must be sortable for use by multiple end-user functions, and includes all data used by the flight crew, ground operations, and flight operators
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.1.  
Referenced from SOW Paragraph(s): 6.1.5.2, 6.2.13
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The CEV Data and Command Dictionary applies to all flight, ground, simulation, and test software and hardware on the CEV Project.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The CEV Data and Command Dictionary shall be a sortable database that includes:  
a. Channelization data (e.g., bus mapping, vehicle wiring mapping, end-to-end hardware channelization (from sensor/transducer, through signal conditioning, and multiplexing, to final destination of measurement), etc.).  
b. I/O variables.  
c. Rate group data.  
d. Raw and calibrated calibration sensor data.  
e. Telemetry format/layout and data.  
f. Data recorder format/layout and data.  
g. Command definition (e.g., on-board, ground, test specific).  
h. Effector command information.  
i. Operational limits (e.g., maximum/minimum values, launch commit criteria information, etc.).  
j. Mapping to the CEV Nomenclature document.  
k. Sensor reference information (e.g., measurement type, signal type, subsystem, installation drawing number, part number).
- 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1. Electronic, XML/XTCE-compatible.

- 135 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.

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## DATA REQUIREMENTS DESCRIPTION (DRD)

- 1     **PROGRAM:** CEV
- 2     **DRD NO.:** CEV-T-047
- 3     **DATA TYPE:** 3
- 4     **DATE REVISED:** 12/21/2005
- 5     **PAGE:** 1
- 6     **TITLE:** Avionics Design and Data Book
- 7     **DESCRIPTION/USE:**  
This DRD covers design information for the CEV Avionics subsystems, including the Command and Data Handling, Instrumentation, Communication and Tracking, and Displays and Controls subsystems. Software design documentation is provided in a separate DRD. This documentation will provide insight into the contractor's design and analysis data, as well as detailed reference information to support Engineering and Operations throughout the life of the CEV.
- 8     **DISTRIBUTION:** As determined by the Contracting Officer
- 9     **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10    **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11    **REMARKS:**
- 12    **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.1.  
Referenced from SOW Paragraph(s): 10.1.2, 6.2.1.2, 6.2.1.3, 6.2.1.4  
Related DRD(s): CEV-T-041
- 13    **DATA PREPARATION INFORMATION:**
- 13.1   **SCOPE:**  
Design and analysis data related to the Avionics subsystem from the initial trade studies, requirements analysis, architecture, math modeling, functional and performance analyses, detailed design, design analysis, and operations and maintenance strategies. Document also covers interfaces with other CEV subsystems, software interfaces, external interfaces, and interfaces with ground/users. Separate volumes shall be provided for each avionics subsystem, as specified below.
- 13.2   **APPLICABLE DOCUMENTS:**  
CXP-00101: Constellation Command, Control, Communication, and Information (C3I) Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)
- 13.3   **CONTENTS:**  
The Avionics DRD shall contain five volumes as follows:  
Volume I: Avionics System-Level Data  
Volume II: Command and Data Handling/Instrumentation Subsystem Data  
Volume III: Communications and Tracking Subsystem Data  
Volume IV: Displays and Controls Subsystem Data  
Volume V: Avionics Subsystem - Constellation C3I Interoperability Report  
  
Volumes I - IV shall include, as applicable to the subsystem, the information listed below:  
1) Assumptions and groundrules  
2) Subsystem Definition including architecture diagrams and GFE vs contractor-supplied assumptions



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- 3) Subsystem Requirements Analyses
  - a. Functional decomposition
  - b. Functional, performance and interface requirements
  - c. Derived requirements on other systems
  - d. Trade study results
  - e. Analysis to show the subsystems and principles of operation
- 4) Detailed Design Description
  - a. Hardware element descriptions including description of system properties
  - b. Mass and volume profiles
  - c. Power and thermal requirements, drawings, and 3-D solid geometric representations of components
  - d. Schematics
  - e. Interfaces including mechanical, electrical and thermal hardware interfaces, and human interfaces; includes necessary control Documents)
  - f. Interface bandwidth/throughput/memory/link margin analysis for hardline, optical data systems and processors as applicable to subsystem
  - g. Telemetry/instrumentation
  - h. Consumables list
  - i. Reconfiguration process
- 5) Operational Analyses
  - a. Operational scenarios and modes including the subsystem's limitations on any aspect of vehicle flight
  - b. Performance and Margin analyses
  - c. Operating Environments (natural and induced)
  - d. Failure modes and redundancy operations including vehicle failure modes accommodated by subsystem and failure modes reacting to vehicle failures
  - e. Fault Detection, Isolation and Recovery
  - f. Diagnostic strategies including plans for in-flight maintenance
  - g. Initialization procedures and parameters
  - h. Day of launch parameters and late-load requirements
  - i. Abort analysis
  - j. Launch scrub turnaround plan
  - k. Labeling strategy (consistent with overall CEV labeling strategy)
- 6) Independent design and performance analyses including worst case timing analysis, fault tolerance and hazard identification/mitigation.
- 7) Maintainability and testing data
  - a. Test requirements including information on Special Test Equipment design, operations and maintenance, if applicable.
  - b. Maintainability strategies including sparring provisions, growth and scarring provisions, shelf-life, and long-term storage provisions
  - c. Deliverable end item or equipment identification (part number)
  - d. Predicted reliability assessment
  - e. Component reusability/refurbishment analysis
- 8) References and indication of any changes from the previous submission
- 9) Additional Communications and Tracking Subsystem Analyses Data (Volume III)
  - a. In addition to the information specified above, Volume III shall include the following analyses reports, with each report provided in a separate section. Each report shall contain the following:
    1. Brief description of the analysis discipline and its overall function.
    2. Summary performance matrix listing each quantitative parameter requirement the discipline is to satisfy against a concise

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statement of the analytically predicted performance of the parameter, whether or not the parameter requirement is met, and a reference to the location in the text where the supporting analysis is described.

3. Supporting analyses which shall discuss all boundary conditions, inputs (including test data), and assumptions used; analytical approaches (models, equations, algorithms) used; results; and conclusions.

4. In cases where computer math models or programs are utilized, a description of the program along with the source code are to be delivered.

b. Required Analysis Reports:

1. Radio Frequency/Optical Link Margin Data book - Documents link margin for each RF link.

2. RF/Optical Coverage Analysis Report - Report of RF link availability considering vehicle trajectory, antenna patterns, structural blockage, planet blockage, and link margin.

3. Radiation Patterns - Documents planned performance at PDR and test measurements as available.

4. Emitter/Receiver pointing analysis - Analysis of antenna/laser pointing accuracy and stability considering all sources of pointing errors.

5. RF/Optical Radiation analysis - Analysis to show RF/Optical system compliance relating to RF/Optical operations and constraints with the launch site, vehicles and facilities.

6. Tracking analysis - Analysis to show that RF/Optical tracking systems meet system requirements.

7. RF/Optical Interference Analysis - Provide analysis or measured data showing that no other vehicle subsystems or components prevent the reception, transmission, or operation of RF communication subsystems and components. Similarly, provide analysis or measured data showing that no RF communication subsystem or components interfere with the proper operation of other vehicle subsystems or components.

Volume V shall include:

1) Description of how the CEV contractor plans to implement CXP-00101, Constellation Command, Control, Communication, and Information (C3I) Interoperability Specification (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)

2) Provides a summation and targeted details of designs for vehicle systems that support command, control, and monitoring, including:

a. Communications protocols

b. Information model content related to command, control, communications, and monitoring

c. Communications framework supporting collaborative data sharing and distribution

134 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

135 **MAINTENANCE:** Changes shall be identified and complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

- |    |                     |    |                                |
|----|---------------------|----|--------------------------------|
| 1. | <b>PROGRAM:</b> CEV | 2  | <b>DRD NO.:</b> CEV-T-048      |
| 3  | <b>DATA TYPE:</b> 1 | 4  | <b>DATE REVISED:</b> 12/5/2005 |
|    |                     | 5. | <b>PAGE:</b> 1                 |
- 6 **TITLE:** Software Requirements Specification
- 7 **DESCRIPTION/USE:**  
A document which defines and records the software requirements to be met by a computer software configuration item (CSCI). This document specifies the requirements for a CSCI and the methods to be used to ensure that each requirement has been met. This document forms the basis for design and qualification testing of a CSCI.
- 8 **DISTRIBUTION:** As determined by the Contracting Officer.
- 9 **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10 **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11 **REMARKS:**  
Requirements pertaining to the CSCI's external interfaces may be presented in the Software Requirements Specification (SRS) or in one or more Interface Requirements Specifications (IRS's) referenced from the SRS.  
The following document(s) may be used as guidance:  
• IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes  
• IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data
- 12 **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.1.1.  
Referenced from SOW Paragraph(s): 6.1.3, 6.2.12, 9.2  
Related DRD(s): CEV-O-008, CEV-T-035
- 13 **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Software Requirements Specification details the software functional, performance, interface, operational, and quality assurance requirements.
- 13.2 **APPLICABLE DOCUMENTS:**  
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)
- 13.3 **CONTENTS:**  
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as guidance, the Software Requirements Specification shall contain:  
a. System overview.  
b. CSCI requirements.  
    1. Functional requirements.  
    2. Required states and modes.  
    3. External interface requirements.  
    4. Internal interface requirements.

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5. Internal data requirements.
6. Adaptation requirements.
7. Safety requirements.
8. Performance and timing requirements.
9. Security and privacy requirements.
10. Environment requirements.
11. Computer resource requirements.
  - (a). Computer hardware resource utilization requirements.
  - (b). Computer software utilization requirements.
  - (c). Computer communications requirements.
12. Software quality characteristics.
13. Design and implementation constraints.
14. Personnel-related requirements.
15. Training-related requirements.
16. Logistics-related requirements.
17. Packaging requirements.
18. Precedence and criticality of requirements.
19. Operations requirements, including flight-to-flight reconfiguration.
- c. Qualification provisions.
- d. Requirements traceability and verification method data.
- e. Requirements partitioning for phased delivery
- f. Testing requirements that drive software design decisions; e.g., special system level timing requirements/checkpoint restart.

13.4 **FORMAT**: Electronic format per Section J-2 2.3 2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified.

## DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-049
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/5/2005
5. **PAGE:** 1
6. **TITLE:** Monthly Software Metrics Report
7. **DESCRIPTION/USE:**  
To provide visibility to contractor and government project management of actual and potential problems and progress toward meeting the cost, technical and schedule requirements
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
The following document(s) may be used as guidance:
  - IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
  - IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.1.1.
13. **DATA PREPARATION INFORMATION:**
- 13.1. **SCOPE:**  
The Monthly Software Metrics Report provides data for the assessment of software cost, technical, and schedule progress.
- 13.2. **APPLICABLE DOCUMENTS:**  
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)
- 13.3. **CONTENTS:**  
In accordance with NPR 7150.2 NASA Software Engineering Requirements, the Monthly Software Metrics Report shall contain as a minimum the following information tracked on a CSCI basis monthly:
  - a. Software resources - planned vs. actual.
  - b. Software development schedule tasks (e.g., milestones) (planned vs. actual).
  - c. Requirements stability - number of software requirements, number of requirements changes, and number of TBD's.
  - d. Software size in agreed upon measurement units (e.g. source lines of code (SLOC)) - planned vs. actual.
  - e. Computer resource utilization in percentage of capacity (e.g. memory, processor, I/O throughput) with agreed upon thresholds.
  - f. Number of test cases successfully developed, dry run, and used for formal test - planned vs. actual.
  - g. Number of Computer Software Units (CSUs) in design phase, in coding phase, coded and under Configuration Management (CM), completed Unit

Test, and Integrated into Computer Software Configuration Item (CSCI).  
h. Number of requirements included in a completed build/release (planned vs. actual).  
i. Number of software problem reports and review item discrepancies - open, closed and withdrawn  
j. Number of Peer Reviews/Software Inspections - planned vs. actual.  
k. Number and classification of findings found during Peer Reviews/Software Inspections.  
l. Number of Software Audits - planned vs. actual.  
To the extent information regarding (a) through (l) above is not provided, the contractor shall provide documented justification in the Monthly Software Metrics Report. Other information may be provided at the contractor's discretion to assist in evaluating the cost, technical, and schedule performance; e.g., innovative processes and cost reduction initiatives.

134 **FORMAI**: Electronic format per Section J-2 2.3.2.1.

135 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-050
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/19/2005
5. **PAGE:** 1
6. **TITLE:** Software Design Description
7. **DESCRIPTION/USE:**  
To define and record the design of a computer software configuration item (CSCI). To be used as the basis for implementing the software, and to provide visibility into the design and the information needed for software support
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
The following document(s) may be used as guidance:
  - IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
  - IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.1.1.  
Referenced from SOW Paragraph(s): 9.2
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Software Design Description describes the design of a CSCI. It describes the CSCI-wide design decisions, the CSCI architectural design, and the detailed design needed to implement the software.
- 13.2 **APPLICABLE DOCUMENTS:**  
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)
- 13.3 **CONTENTS:**  
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as guidance, the Software Design Description shall include:
  - a. CSCI-wide design decisions/trade decisions.
  - b. CSCI architectural design.
  - c. CSCI decomposition and interrelationship between components.
    1. CSCI components:
      - (a) Description of how the software item satisfies the software requirements, including algorithms, data structures, and functional decomposition.
      - (b) Software item input/output description.
      - (c) Static/architectural relationship of the software units.
      - (d) Concept of execution including data flow, control flow,

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and timing.

(e) Requirements traceability.

(f) CSCI's planned utilization of computer hardware

resources.

2. Rationale for software item design decisions/trade decisions including assumptions, limitations, safety and reliability related items/concerns or constraints in design documentation.

3. Interface design.

d. CSCI Implementation Plan.

134 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

135 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified.





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breakdown and issues classification breakdown).

e. Inspection results summary (i.e., pass, re-inspection required, etc.).

f. Listing of all inspection defects.

g. Electronic copy of item being inspected.

13.4 **FORMAT**: Electronic format per Section J-2 2.3 2.1.

13.5 **MAINTENANCE**: N/A

## DATA REQUIREMENTS DESCRIPTION (DRD)

- |    |                     |    |                                |
|----|---------------------|----|--------------------------------|
| 1. | <b>PROGRAM:</b> CEV | 2  | <b>DRD NO.:</b> CEV-T-052      |
| 3  | <b>DATA TYPE:</b> 2 | 4. | <b>DATE REVISED:</b> 12/5/2005 |
|    |                     | 5. | <b>PAGE:</b> 1                 |
- 6 **TITLE:** Software Test Plan
- 7 **DESCRIPTION/USE:**  
To develop, record, and assess plans for conducting computer software component level testing, software integration testing, software qualification testing, and system qualification testing of a software system.
- 8 **DISTRIBUTION:** As determined by the Contracting Officer.
- 9 **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10 **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11 **REMARKS:**  
The following document(s) may be used as guidance:  
• IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes  
• IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data
- 12 **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.1.1.  
Referenced from SOW Paragraph(s): 9.2  
Related DRD(s): CEV-T-015
- 13 **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Software Test Plan describes the plans for software component level testing, software integration testing, software qualification testing, and system qualification testing of software systems. The plan describes the software test environment to be used for testing, identifies the tests to be performed, and provides schedules for environment, development, and test activities. The plan provides an overview of software testing, test schedules, and test management procedures.
- 13.2 **APPLICABLE DOCUMENTS:**  
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)
- 13.3 **CONTENTS:**  
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as guidance, the Software Test Plan shall include:  
a. Test levels.  
b. Test types (e.g., unit testing, software integration testing, systems integration testing, end-to-end testing, acceptance testing, regression testing).  
c. Test classes.  
d. General test conditions.

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- e. Test progression.
- f. Data recording, reduction, and analysis.
- g. Test coverage (breadth and depth) or other methods for ensuring sufficiency of testing.
- h. Planned tests, including items and their identifiers.
- i. Test schedules.
- j. Requirements traceability (or verification matrix), showing bi-directional traceability to requirements and design.
- k. Qualification testing environment, site, personnel, and participating organizations.
- l. Identification of testing requirements that drive software design decisions, e.g., special system level timing requirements/checkpoint restart.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-053
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/5/2005
5. **PAGE:** 1
6. **TITLE:** Software Test Description
7. **DESCRIPTION/USE:**  
To describe the test preparations, test cases, and test procedures to be used to perform qualification testing of a CSCI or a software system or subsystem
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
The following document(s) may be used as guidance:
  - IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
  - IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.1.1.  
Referenced from SOW Paragraph(s): 9.2  
Related DRD(s): CEV-T-054
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Software Test Description describes the test preparations, test cases, and test procedures to be used to perform qualification testing of a CSCI or a software system or subsystem.
- 13.2 **APPLICABLE DOCUMENTS:**  
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)
- 13.3 **CONTENTS:**  
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as guidance, the Software Test Description shall include:
  - a. Test preparations, including hardware and software.
  - b. Test procedures, including:
    - 1) Test identifier.
    - 2) System or CSCI requirements addressed by the test case.
    - 3) Prerequisite conditions.
    - 4) Test input.
    - 5) Instructions for conducting procedure.
    - 6) Expected test results, including criteria for evaluating results, and assumptions and constraints.
    - 7) Test pass/fail criteria.

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- c. Requirements traceability.
- d Identification of test configuration.

134 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

135 **MAINTENANCE:** Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified.

## DATA REQUIREMENTS DESCRIPTION (DRD)

- |    |                     |    |                                |
|----|---------------------|----|--------------------------------|
| 1. | <b>PROGRAM:</b> CEV | 2  | <b>DRD NO.:</b> CEV-T-054      |
| 3  | <b>DATA TYPE:</b> 2 | 4. | <b>DATE REVISED:</b> 12/5/2005 |
|    |                     | 5  | <b>PAGE:</b> 1                 |
- 6 **TITLE:** Software Test Report
- 7 **DESCRIPTION/USE:**  
To record the qualification testing performed on a CSCI, a software system or subsystem, or other software-related item.
- 8 **DISTRIBUTION:** As determined by the Contracting Officer.
- 9 **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10 **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11 **REMARKS:**  
The following document(s) may be used as guidance:  
• IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes  
• IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data
- 12 **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 6.2.1.1.  
Related DRD(s): CEV-T-053
- 13 **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Software Test Report is a record of the qualification testing performed on a CSCI, a software system or subsystem, or other software-related item.
- 13.2 **APPLICABLE DOCUMENTS:**  
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)
- 13.3 **CONTENTS:**  
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as guidance, the Software Test Report shall include:  
a. Overview of the test results.  
1) Overall assessment of the software as demonstrated by the test results.  
2) Remaining deficiencies, limitations, or constraints detected by testing. (e.g., including description of the impact on software and system performance, the impact a correction would have on software and system design, and recommendations for correcting the deficiency, limitation, or constraint).  
3) Impact of test environment.  
b. Detailed test results.  
1) Project-unique identifier of a test and test procedure(s).  
2) Summary of test results (e.g., including requirements verified).

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- 3) Problems encountered.
  - 4) Deviations from test cases/procedures.
  - c. Test log.
    - 1) Date(s), time(s), and location(s) of tests performed.
    - 2) Test environment, hardware, and software configurations used for each test.
    - 3) Date and time of each test-related activity, the identity of the individual(s) who performed the activity, and the identities of witnesses, as applicable.
  - d. Rationale for decisions.
- 13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.
- 13.5 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required with changes clearly identified.



**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-001
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Integrated Models, Simulations and Support Plan
7. **DESCRIPTION/USE:**

This DRD defines the periodic delivery of a group of related models and simulations and a Modeling and Simulation Support Plan. The DRD includes:

  1. Architectural models and system diagrams developed using an architectural modeling tool;
  2. A full system, discrete-event simulation model runnable on an analyst's desktop;
  3. High-fidelity simulations implemented as HLA federations;
  4. A Modeling and Simulation Support Plan

These deliveries provide NASA with detailed functional and behavioral views of the CEV design as it matures and with a modular simulation capability to support trade studies, system engineering and integration, flight software development and testing, and operations planning.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix. Initial submission will contain Modeling & Simulation Support Plan, an initial system architecture model, and discrete-event simulations. The addition of HLA federate deliveries will start at Subsystem PDR and continue thereafter.
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix.
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.2.  
Referenced from SOW Paragraph(s): 2.2.1, 2.2.2, 6.1, 6.1.4  
Related DRD(s): CEV-T-002
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**

The Modeling and Simulation Support Plan and associated model deliveries includes all the planning and effort necessary to perform analysis of integrated vehicle performance, environmental effects and resource management plus all simulation models needed for testing system hardware and software. It is expected that all deliveries will cover the full vehicle and that detail, accuracy and scenario coverage will increase as the CEV design matures.
- 13.2 **APPLICABLE DOCUMENTS:**

CXP-02016: NEXIOM Standard for Data Deliverables  
CXP-02017: NEXIOM Standard for Tool, Model and Simulation Deliverables  
CXP-02018: Modeling and Simulation (M&S) Verification and Validation (V&V) Process Plan and Specification  
IEEE 1516 -2000: IEEE Standard for Modeling and Simulation (M&S) High Level Architecture (HLA) -- Framework and Rules  
IEEE 1516.1-2000: IEEE Standard for Modeling and Simulation (M&S) High Level Architecture (HLA) Federate Interface Specification  
IEEE 1516.2-2000: IEEE Standard for Modeling and Simulation (M&S) High

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Level Architecture (HLA). Object Model Template (OMT) Specification  
IEEE1516.3-2000: IEEE Recommended Practice for High Level Architecture  
(HLA) Federation Development and Execution Process (FEDEP)

13.3 **CONTENTS:**

Coverage: Delivered models shall represent all CEV subsystems listed in SOW section 6.2 plus (a) any ground systems and communications models required to simulate intended system function, (b) any relevant vehicle environment models (e.g. gravitational, thermal, electromagnetic, radiation) utilized to evaluate nominal and off-nominal system performance and (c) models of other Constellation elements at a fidelity appropriate to enable evaluation of integrated CEV performance.

The models will emulate nominal performance over a range of inputs corresponding to design parameters to support trade studies as well as off-nominal operations to support safety analysis and flight software testing. Scope of variability for trade studies and off-nominal scenarios will be determined by the Integrated Modeling and Simulation (IM&S) Working Group.

Each delivery for this DRD shall consist of:

1. A revision of the Modeling and Simulation Support Plan
2. An Excel-based manifest listing each model included in the delivery along with the model version and a brief description.
3. A revision of the System Architecture Model. This model shall represent vehicle function, structure and behavior via:
  - (a) Function and component hierarchies
  - (b) An allocation of functions to components
  - (c) Functional models (Functional Data Flow Diagram, IDEF0, extended Function Flow Block Diagram)
  - (d) Dynamic models (State Transition Diagram)
  - (e) UML diagrams (e.g., sequence diagrams, state charts)
  - (f) Architectural (Physical Architecture Diagram, Architecture Interconnect Diagrams)
  - (g) Process (Process Flow Diagram)The System Architecture Model shall be delivered in an electronic format readable by Cradle.
4. A revision of the full-system, desktop, Discrete-Event Simulation that can be run in a COTS tool (e.g., COREsim) or a non-COTS simulation package. If a non-COTS simulation package is used, then the Contractor shall also deliver source code, build files and a compiled version.
  - (a) For the discrete-event simulation model, no constraint is placed on the units of simulation other than good software engineering practice.
  - (b) The Discrete-event Simulation Models be capable of running full vehicle, full-mission scenarios in less than one hour and narrower simulations in 10-20 minutes.
5. Starting at subsystem PDR, an HLA federation with coverage described above and including documentation
  - (a) HLA federates shall be modeled at levels that support modularity, effective reuse and unit testing and that support the needs of software and hardware-in-the-loop testing.
  - (b) The HLA federation shall simulate system performance at least as fast as realtime. When this is not achievable via the HLA protocol, a solution (e.g. Mil-Std 1553) that corresponds to the flight environment will be agreed upon via the Integrated Modeling and Simulation (IM&S) Working Group.
  - (c) Planning and development of HLA federates shall be coordinated with

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development of the Engineering CEV models specified in DRD CEV-T-002. The HLA models shall reuse code or algorithms from the Engineering CEV models where appropriate.

6. Documentation for each model or federate
7. Source code, data files and build files for each model or federate
8. Compiled versions of each model that runs under one of Windows, Macintosh, Linux or another Unix distribution.
9. Source code for tools used to create data used by or included in the models, unless they were created with COTS software

Each revision of the Modeling and Simulation Support Plan shall contain at least these sections:

1. An overview of the Contractor's approach to managing the development of models and simulations
2. A manifest briefly describing each planned model and simulation, what analyses it will help support, the date the model or simulation will be delivered and an indication of which DRD-governed deliverables (if any) the model or simulation contributes to. It is expected that this manifest will contain TBDs. This manifest can optionally be combined with the Excel-based manifest of models actually delivered in this DRD delivery. The Contractor can include additional sections that further describe their modeling and simulation support process or can substitute a document template used internally if it contains this information.

Documentation for each model shall include:

1. An XML document conformant to the CXP-02017, NEXIOM Standard for Tool, Model and Simulation Deliveries;
2. System and Federation Object Models for the HLA federation;
3. Written documentation for each model sufficient for knowledgeable engineers to conduct trade studies or to build models that correctly interface to this one where additional detail is needed over the HLA System and Federation Object Models and NEXIOM portions of this delivery.

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE:** All models shall be utilized for CEV system maturation through operation and therefore maintained to the as-built configuration.

1 PROGRAM: CEV 2 DRD NO.: CEV-T-002  
3 DAIA TYPE: 2 4 DATE REVISED: 12/19/2005  
5 PAGE: 1

6 TITLE: CEV Engineering Models

7 DESCRIPTION/USE:  
This DRD defines the periodic delivery of engineering models of the CEV system, modules, subsystems, and components. These models will be discipline (e.g. aerothermal, structural loads, trajectory), mission (e.g. logistics planners, sequence planners) and system (e.g. sizers, cost estimators, risk estimators) oriented and will be implemented using many different tools and data formats. These models are different in nature than models addressed in CEV-T-001 (Integrated Models, Simulations and Support Plan) in that they do not represent strict mission-time-line simulations. CEV-T-001 should be referred to for all mission time-stepped models and simulations.

These models provide NASA and the Contractor with design and operational trade study results that guide system and mission design decisions. These models are used by NASA and the Contractor in day-to-day design and analysis activities. NASA requires informed application of available tools and models based on their capability and applicability to CEV design issues as they arise.

Models of this type are called out in several DRDs, including CEV-T-009 (CEV Analysis Report) as well as discipline and system oriented data books and mathematical model DRDs. NASA intends to have insight and understanding into the applicability and provenance of these models. NASA intends to own a searchable electronic store of CXP-02017, NEXIOM Standard for Tool, Model and Simulation Deliveries conformant documents for each tool, model or simulation utilized in the development of the CEV.

8 DISTRIBUTION: As determined by the Contracting Officer.

9 INITIAL SUBMISSION: 45 days prior to SDR per Data Requirements Matrix.

10 SUBMISSION FREQUENCY: Per Data Requirements Matrix.

11 REMARKS:

12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 2.1.2.  
Referenced from SOW Paragraph(s): 2.2.1, 2.2.2, 6.1, 6.1.4, 6.2  
Related DRD(s): CEV-T-001, CEV-T-009

13 DATA PREPARATION INFORMATION:

13.1 SCOPE:  
This DRD applies to tools, models and simulations that are:

- a) Not covered by CEV-T-001, Integrated Models, Simulations and Support Plan.
- b) Direct or indirect sources of data delivered in any other DRD
- c) Direct or indirect sources of data utilized in a CEV Project review milestones.

Attachment J-2  
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estimators, environmental models, scenario planners, failure calculators, and cost estimation utilities. Models of other types are also covered per the requirements of SOW section 2.1.2.

**13.2 APPLICABLE DOCUMENTS:**

CXP-02016: NEXIOM Standard for Data Deliverables

CXP-02017: NEXIOM Standard for Tool, Model and Simulation Deliverables

CXP-02018: Modeling and Simulation (M&S) Verification and Validation (V&V) Process Plan and Specification

**13.3 CONTENTS:**

Each CEV Model delivery shall consist of:

- a. A report conformant to the CXP-02017, NEXIOM Standard for Tool, Model and Simulation Deliveries for each model contained in the delivery.
- b. Any pre-existing technical documentation including user manuals and technical publications.
- c. Source code and build files for all models.
- d. Compiled versions that run under one of Windows, Macintosh, Linux and UNIX variants.
- e. Source code for tools used to create lookup tables within the models, unless they were created with COTS software.
- f. Lookup tables utilized within the models.

**13.4 FORMAT:** Model format shall be the native format associated with the model being delivered. When other DRDs call out a specific format (e.g. NASTRAN, etc ) then the delivery format requirements called out in that DRD shall be adhered to. Electronic format requirements per Section J-2 2.3.2.1 shall be followed as well.**13.5 MAINTENANCE:** All models shall be utilized for CEV system maturation through operation and therefore maintained to the as-built configuration.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

- |   |                     |   |                      |           |
|---|---------------------|---|----------------------|-----------|
| 1 | <b>PROGRAM:</b> CEV | 2 | <b>DRD NO.:</b>      | CEV-T-003 |
| 3 | <b>DATA TYPE:</b> 2 | 4 | <b>DATE REVISED:</b> | 12/5/2005 |
|   |                     | 5 | <b>PAGE:</b>         | 1         |
- 6     **TITLE:** CEV CAD Models
- 7     **DESCRIPTION/USE:**  
CEV CAD models will include all solid models, surface models and associated construction references, such as coordinate systems and datum planes, used by the contractor in the design, layout, manufacturing, assembly, testing, certification and flight hardware processing of the delivered CEV System and associated Contractor-provided ground systems. The level of detail presented in the 2-D and 3-D CEV CAD models will progress from the system, module, and sub-system level to the component level over the course of the CEV Project lifecycle. The end state will be such that all CAD models utilized by the Contractor and their subtiers shall be delivered to NASA. The aggregate set of models shall define every dimension of the CEV.
- 8     **DISTRIBUTION:** As determined by the Contracting Officer.
- 9     **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10    **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11    **REMARKS:**
- 12    **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.2.  
Referenced from SOW Paragraph(s): 6.1, 6.2.5, 6.2.7, 9.2
- 13    **DATA PREPARATION INFORMATION:**
- 13.1   **SCOPE:**  
This document covers 2-D and 3-D CAD model developed by the Contractor for any CEV and Contractor-provided ground system, module, subsystem, and component. This specifically includes wiring, piping, ducting, all outer mold lines and mechanisms. All models must include material properties, identification and composition information for all parts represented by the model.
- 13.2   **APPLICABLE DOCUMENTS:**
- 13.3   **CONENTS:**  
Detailed solid models shall be provided for the design, layout, manufacturing, assembly, testing, certification and flight hardware processing of the delivered CEV Systems according to the scope outlined in this DRD. The detailed solid models shall be 2-D and 3-D and shall include the parameters, coordinate systems(s), datum planes, surfaces, axes, points used for model construction and reference purposes. In addition, simplified graphical representations of components, subassemblies and assemblies shall be provided, when such representations are not generated by the ICE system.
- 13.4   **FORMAT:** Electronic format per Section J-2 2.3.2.1.
- 13.5   **MAINTENANCE:** All CAD models shall be maintained to reflect the spacecraft and ground systems as-built configuration.

DATA REQUIREMENTS DESCRIPTION (DRD)

- 1     **PROGRAM:** CEV
- 2     **DRD NO.:** CEV-T-004
- 3     **DATA TYPE:** 3
- 4     **DATE REVISED:** 12/5/2005
- 5     **PAGE:** 1
- 6     **TITLE:** CEV Drawings
- 7     **DESCRIPTION/USE:**  
CEV Drawings includes released manufacturing, layout, assembly and installation drawings and schematics for all modules, subsystems, and components of the CEV System. The level of detail presented in CEV drawings will progress from the system and sub-system level to the component level over the course of the CEV Project lifecycle. The end state will be such that all drawings utilized by the Contractor and their subtiers shall be delivered to NASA. The aggregate set of drawings shall define every dimension of the CEV.
- 8     **DISTRIBUTION:** As determined by the Contracting Officer.
- 9     **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10    **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11    **REMARKS:**
- 12    **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.2.  
Referenced from SOW Paragraph(s): 6.1, 6.2.7, 9.2
- 13    **DATA PREPARATION INFORMATION:**
- 13.1   **SCOPE:**  
This document covers all drawings developed by the Contractor for any CEV or ground system, subsystem, or component. This specifically includes wiring, piping, ducting, all outer mold lines and mechanisms. All drawings must include material properties, identification and composition information for all parts represented by the drawing.
- 13.2   **APPLICABLE DOCUMENTS:**  
ASME Y14.100: Engineering Drawing Practices  
ASME Y14.24: Types and Applications Of Engineering Drawings  
ASME Y14.34M: Associated Lists  
ASME Y14.35M: Engineering Drawings and Associated Documents
- 13.3   **CONTENTS:**  
All released manufacturing, assembly, installation and layout drawings and schematics of the CEV System, modules and subsystems including all components, subassemblies and assemblies to include:
  - a) Manufacturing drawings
  - b) Assembly drawings
  - c) Installation drawings
  - d) Layouts
  - e) Schematics
- 13.4   **FORMAT:** Electronic format per Section J-2 2 3.2.1. The Contractor shall deliver the native, working file regardless of format plus a searchable PDF output for each drawing. All drawings shall be directly derived from solid CAD models when CAD models exist.

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- 135 MAINTENANCE: CEV drawings and schematics shall be maintained to reflect the spacecraft and ground systems as-built configuration.



**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-005
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/20/2005
5. **PAGE:** 1
6. **TITLE:** Software Development Plan
7. **DESCRIPTION/USE:**  
A plan for conducting the software development effort. This DRD develops and records the plans for all software development activities
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
The term 'software development' is meant to include new development, modification, reuse, reengineering, maintenance, and all other activities resulting in software products.  
The following document(s) may be used as guidance:
  - CXP-02009: Constellation Software Classification Matrix (use as guidance in interpreting flight software classification definitions in NPR 7150.2)
  - IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes
  - IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.4.  
Referenced from SOW Paragraph(s): 6.2.1.1, 9.2  
Related DRD(s): CEV-O-008, CEV-S-001
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Software Development Plan provides insight into, and a tool for monitoring, the processes to be followed for software development, the methods to be used, the approach to be followed for each activity, and project schedules, organization, and resources. This plan details the system software, project documentation, project schedules, resources requirements and constraints, and general and detailed software development activities.
- 13.2 **APPLICABLE DOCUMENTS:**  
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)
- 13.3 **CONTENTS:**  
In accordance with NPR 7150.2, NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as guidance, the Software Development Plan shall contain:
  - (a) Project organizational structure showing authority and responsibility of each organizational unit, including external organizations (i.e.,

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- Safety and Mission Assurance, Independent Verification and Validation (IV&V)).
- (b) The classification of each of the systems and subsystems containing software as defined in Appendix B of NPR 7150.2 and CXP-02009, Constellation Software Classification Matrix (use as guidance in interpreting flight software classification definitions in NPR 7150.2).
  - (c) Tailoring compliance matrix for approval by the CEV Project management, if the contractor proposes any variants, waivers or exceptions to NPR 7150.2.
  - (d) Engineering environment (for development, operation or maintenance, as applicable), including test environment, library, equipment, facilities, standards, procedures, and tools.
  - (e) Work Breakdown Structure (WBS) of the life cycle processes and activities, including the software products, software services, and non-deliverable items to be performed. The WBS also includes budgets, staffing, physical resources, software size, and schedules associated with the tasks.
  - (f) Management of the quality characteristics of the software products or services.
  - (g) Management of safety, security, privacy, and other critical requirements of the software products or services.
  - (h) Subcontractor management, including subcontractor selection and involvement between the subcontractor and the acquirer, if any.
  - (i) Quality assurance.
  - (j) Verification and validation, including the approach for interfacing with the independent verification and validation agent.
  - (k) Acquirer involvement.
  - (l) User involvement.
  - (m) Risk management.
  - (n) Security policy.
  - (o) Approval required by such means as regulations, required certifications, proprietary, usage, ownership, warranty and licensing rights.
  - (p) Process for scheduling, tracking, and reporting.
  - (q) Training of personnel.
  - (r) Software life cycle model including description of development methodology and approach, software integration and hardware/software integration processes, software delivery, and maintenance/regression testing.
  - (s) Configuration management process of all software products, including this document.
  - (t) Software documentation tree.
  - (u) Peer review/inspection/walkthrough process of all software work products.
  - (v) Process for early identification of testing requirements that drive software design decisions, e.g., special system level timing requirements/checkpoint restart.
  - (w) Software metrics.
  - (x) Content of software documentation to be developed on the project.
  - (y) Justification for reuse of existing software, modification of existing software, and the development of new software. For reuse of existing software, a map must be developed which shows the original requirements associated with the existing software matrixed against the CEV requirements to demonstrate that the reuse is appropriate.
  - (z) Reconfiguration process.

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE:** Contractor-proposed changes to document shall be submitted to NASA for approval. Changes shall be identified and complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

- |    |                     |    |                      |            |
|----|---------------------|----|----------------------|------------|
| 1. | <b>PROGRAM:</b> CEV | 2  | <b>DRD NO.:</b>      | CEV-T-006  |
| 3. | <b>DATA TYPE:</b> 2 | 4. | <b>DATE REVISED:</b> | 12/20/2005 |
|    |                     | 5. | <b>PAGE:</b>         | 1          |
- 6 **TITLE:** Software Configuration Management Plan
- 7 **DESCRIPTION/USE:**  
To describe a plan for performing Software Configuration Management (SCM).
- 8 **DISTRIBUTION:** As determined by the Contracting Officer
- 9 **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10 **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11 **REMARKS:**  
The following document(s) may be used as guidance:  
• IEEE/EIA 12207.0-1996: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes  
• IEEE/EIA 12207.1-1997: Industry Implementation of International Standard ISO/IEC 12207: 1995, Standard for Information Technology - Software life cycle processes - Lifecycle data
- 12 **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.4.  
Related DRD(s): CEV-M-003, CEV-S-001
- 13 **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Software Configuration Management Plan describes the functions, responsibilities, and authority for the accomplishment and implementation of software configuration management to be performed during the full term of performance of the contract. This plan identifies the required coordination of software configuration management activities with other activities of the project.
- 13.2 **APPLICABLE DOCUMENTS:**  
NPR 7150.2: NASA Software Engineering Requirements (all shall statements/the compliance matrix only, excluding the software safety requirement)
- 13.3 **CONTENTS:**  
In accordance with NPR 7150.2 NASA Software Engineering Requirements, and using IEEE/EIA 12207.1-1997 as guidance, the Software Configuration Management Plan shall contain:  
(a) Introduction information, including the purpose of the Plan, the scope, the definition of key terms and references.  
(b) SCM management, including the project organization(s) within which SCM is to apply, SCM responsibilities of these organizations, and references to the SCM policies and directives that apply to the project.  
(c) SCM activities information, which identifies all functions and tasks required to manage the configuration of the software, including configuration identification, configuration control, status accounting, and configuration audits and reviews.  
(d) SCM schedule information, which establishes the sequence and

coordination for the identified SCM activities and for all events affecting the Plan's implementation

(e) SCM resource information, which identifies the software tools, techniques, and equipment necessary for the implementation of the specified SCM activities.

(f) SCM Plan maintenance information, which identifies the activities and responsibilities necessary to ensure continued SCM planning during the lifecycle of the project.

(g) Software release management and delivery.

(h) Software problem reporting and corrective action process.

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE:** Contractor-proposed changes to document shall be submitted to NASA for approval. Changes shall be identified and complete re-issue of the document is required.

## DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM:** CEV
2. **SOW NO.:** CEV-T-007
3. **DATA TYPE:** 5
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Software Development Folder
7. **DESCRIPTION/USE:**  
A repository for material pertinent to the development of a given software unit or set of related units, collected as the requirements and design mature and testing progresses. This information will be used by NASA to provide additional insight into the contractor's flight, ground, and test software effort and products. Each folder shall be 'mirrored' in ICE on a weekly basis.
8. **DISTRIBUTION:** determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.4.  
Referenced from SOW Paragraph(s): 6.2.1.1, 9.2
13. **DATA PREPARATION INFORMATION:**
- 13.1. **SCOPE:**  
Software Development Folders (SDFs) should be used to consistently document each Computer Software Configuration Item (CSCI) and the corresponding Computer Software Components (CSCs) and Computer Software Units (CSUs), to aid in their integration, and to ensure that all required tests have been completed for all CSCs and CSUs. A SDF shall be maintained at the functional software level (i.e. at least one per CSCI, and perhaps one per CSC, dependent upon software complexity and hierarchical structure of the software). Contents include the requirements, design, technical reports, code listings, test plans, test procedures, test results, inspection results, problem reports, change requests, schedules, and notes related to the CSCIs, CSCs, and CSUs. The SDFs also serve as repositories for preliminary and interim software requirements, design rationale, documentation of prototyping efforts, project review documentation, test plans for, and results of, unit and integration tests, notes, and preliminary versions of user documentation.
- 13.2. **APPLICABLE DOCUMENTS:**
- 13.3. **CONTENTS:**  
Each SDF shall contain:  
(a) CSCI/CSC/CSU description, including a brief overview of the function of the CSCI/CSC/CSU, a list of CSCI-to-CSCI, CSC-to-CSC, CSU-to-CSU interfaces, a list identifying any subtier CSCs (for a CSCI SDF) or CSUs, (for a CSC SDF) and identifies the hardware in which the CSCI/CSC/CSU is embedded and any hardware interfaces.  
(b) Detailed schedule, showing when each major milestone (i.e., preliminary design review, critical design review, etc.) occurs and how the CSCI/CSC/CSU schedule relates to the review cycle.  
(c) Review comments and status, providing status on action items given

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during each design, code, and test inspection, and for each major life cycle milestone related to this CSCI/CSC/CSU.

(d) Design notes, including a current copy of any preliminary and detailed design presentations, informal design ideas and notes, design drivers and rationale, and notes on any informal interface agreements between CSCIs/CSCs/CSUs.

(e) Software source listing - either a current electronic listing of the source code or a reference to the directory path and file name, as reflected/mirrored on the ICE, where the code can be found

(f) Unit, CSC, and CSCI integration and test data, including all data pertaining to the integration and testing of each CSU, CSC, and CSCI. The information includes the test procedure, the test environment and configuration (i.e. hardware configuration identification or emulated/simulated configuration), the version ID of the tested software, the date the test was performed, a summary of the test results, printouts of the test data, test notes, source listings of any drivers or stubs, and programmer and/or management certification that the test was completed successfully.

(g) Discrepancy Reports/Change Requests/Problem Reports, including all discrepancy reports and change requests currently open against this CSCI/CSC/CSU.

(h) Preliminary user documentation and notes

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE:** N/A

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-008
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** CEV System Analysis Plan
7. **DESCRIPTION/USE:**

The purpose of this document is to describe the overall plan/approach the contractor shall implement for completing all analyses and trade studies required for the development and delivery, as an end product, of the Crew Exploration Vehicle (CEV) to NASA. The plan should be formulated based on Requirement Analysis Cycles (RACs), Design Analysis Cycles (DACs), and Verification Analysis Cycles (VACs) that tie directly to major milestones, major events (e.g., verification tests), etc. of the CEV development/delivery. Note, this plan should include assessments for the operational use of the CEV, but does not include studies/updates to be completed after delivery of the CEV which will be addressed in another product. This plan should serve as a single-source catalog of information to personnel performing the analyses and trade studies as a part of any analysis cycle, for NASA personnel responsible for monitoring the contractor's activities, and for overall implementation of the CEV program.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Draft due at proposal
10. **SUBMISSION FREQUENCY:** Baseline at IBR, and updates each cycle
11. **REMARKS:**

Contractor may propose the use of task sheets or other formats inclusive to the plan.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.5.
13. **DATA PREPARATION INFORMATION:**
- 13.1. **SCOPE:**

See 13.3 Contents below.
- 13.2. **APPLICABLE DOCUMENTS:**
- 13.3. **CONTENTS:**

The minimum content for this plan is described below.

  1. A description of the contractor's methodology for implementation of the overall CEV Master Analysis Plan and Schedule, to include issue resolution, change requests, etc.
  2. A description of the contractor's methodology for ensuring compliance with the overall CEV development/design requirements and schedule(s)
  3. The contractor's methodology to use this plan and its implementation to provide an understanding of the CEV performance as a part of an integrated vehicle system (e.g., CEV mated to CLV, CEV docked with the ISS, etc.)

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4. A description of the contractor's methodology for ensuring consistency among assessments, analyses and trade studies

5. Clearly identified roles and responsibilities between the contractor organization and NASA relative to implementing the CEV Master Analysis Plan and Schedule, the supporting RACs, DACs, and VACs, etc. Note, this can include required reviews/concurrences of the plan and updates, required information exchange/dependencies, contractual obligations, etc.

6. Identification of the analyses to be completed, with an identifier for each cycle (e.g., number, letter)

7. A description of the contractor's methodology for completion/closeout of all activities within an analysis cycle; note, may include planned presentation(s), solicitation for comments/feedback, action item closures, final report(s), etc.

8. For each RAC/DAC/VAC planned,

(a) A listing and description of all analyses, assessments and trade studies to be completed as a part of this cycle. Note, the description may include the fidelity of the product to be provided (e.g., draft, initial baseline, update)

(b) A description or matrix of the interdependencies between the analyses etc. completed as a part of this cycle and/or other cycles

(c) A description of the configuration(s) assumed/to be utilized for the CEV for the analyses of this cycle. Note, this is meant to provide supporting information for the analyses and ensure the CEV is capable of performing in the planned operational scenarios

(d) A description of the common assumptions and input data for all personnel performing the analyses and trade studies to use as a part of this cycle, with rationale and/or the source for this information identified

(e) Any required matrices or other assessment tools to ensure the products for any cycle satisfy the requirements of the overall CEV program (e.g., matrix cross-referencing the analyses to the CEV verification plan)

(f) A listing of all products/deliverables required for this specific cycle, including the proposed format for each or identification of a 'go-by' as an example. Note, where possible the contractor should strive for simplicity and clarity in the delivered products (e.g., short analyses summaries and/or executive summaries with supporting data, internal documents available on request, use of web site or share area rather than paper distributions, etc.)

(g) A matrix or description of which products are to be provided by the contractor versus NASA personnel, with rationale for the proposed approach. Note, this can include redundant assessments if required for verification/validation of the contractor's products of the problem or objective that motivated the innovation's development.

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1

13.5 **MAINTENANCE:** Contractor-proposed changes to document shall be submitted to NASA for approval. Updates to the plan that is baselined at IBR must be provided for each cycle, and the contractor must account for the time required for NASA review and approval in their outlined schedule.



**DATA REQUIREMENTS DESCRIPTION (DRD)**

- |    |                     |    |                      |            |
|----|---------------------|----|----------------------|------------|
| 1  | <b>PROGRAM:</b> CEV | 2. | <b>DRD NO.:</b>      | CEV-T-009  |
| 3. | <b>DATA TYPE:</b> 3 | 4. | <b>DATE REVISED:</b> | 12/19/2005 |
|    |                     | 5  | <b>PAGE:</b>         | 1          |
6. **TITLE:** CEV Analysis Reports
- 7 **DESCRIPTION/USE:**  
To document results of analyses performed in support of the Contractor and NASA's System Analysis Plans.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
- 9 **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11 **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.5.  
Referenced from SOW Paragraph(s): 6.2.1.1  
Related DRD(s): CEV-T-002
- 13 **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The CEV Analysis Reports document the results of the Contractor's analyses performed as described in their CEV System Analysis Plan.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The CEV Analysis Reports shall document the contractor's decision rationale and address the requirement definition and validation, design definition, and verification analyses performed, ground rules and assumptions used, and decision criteria, Figure of Merits (FOMs), and rationale for each trade performed in support of the System design analysis. The cost estimation methodology shall also be described.
- Each report shall include sections for Executive Summary, Study Objectives, Study Requirements and Constraints, Ground-rules, Assumptions, Initializing Data, Analytical Tools and Models Used (including delivery of Physical Concept Models and Simulations, and Internal Verification and Validation Results, if applicable), Detailed Results and Key Findings/Recommendations.
- 13.4 **FORMAT:** The contractor shall document the linkage of the trade study results that validate CEV System Level requirements within the requirements traceability capability.
- 13.5 **MAINTENANCE:** Changes shall be identified and complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-010
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** System Performance Analysis Report
7. **DESCRIPTION/USE:**

This deliverable is used to verify the integrated system performance of the CEV Spacecraft through analysis of the spacecraft subsystems' requirements in the relevant design environments. This deliverable provides a summary of the findings for each analysis cycle, showing progress along the trade tree and giving key data backing up those findings. This DRD is used to archive the rationale for decisions made in the project during each of these analysis cycles, and can be used to provide key decision summaries to project management.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.5.  
Referenced from SOW Paragraph(s): 2.2.1, 2.2.2, 2.3, 6.1.2
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**

The System Performance Analysis Report will serve as an integration and analysis tool for determining that the CEV System will meet its performance and operational requirements and for documenting the rationale on all analysis cycle decisions.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**

The System Performance Analysis Report shall

  - (a) provide the detailed analysis of the integrated performance for all mission phases (including operations) of the CEV Spacecraft in the relevant design environments.
  - (b) document results from integrating multiple analyses conducted during a given analysis cycle and document the resulting key findings, including recommendations for modifications to the integrated analysis plan, performance metrics and Figures of Merits (FOMs), and selection recommendations, with rationale
  - (c) document in summary fashion the trades conducted, ground rules, assumptions, and initializing data used, analytical tools and models used, selection criteria/rationale, FOMs assessed, the requirements validated or verified, recommended changes with associated rationale, and interface and interoperability issues and recommendations.
  - (d) Operational sequences/scenarios which include utilization environments, measures of effectiveness (MOEs), and how the system products should be used.

Each report shall include the following sections:

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- (a) Executive Summary
- (b) Analysis Cycle Objectives
- (c) Analysis Cycle Requirements and Constraints
- (d) Initializing Data References
- (e) Summary Results
- (f) Key Findings/Recommendations.

Integrated performance analysis shall include the following products:

- (a) Thermal analysis of the spacecraft including components and habitable volume to ensure adequate heat rejection capability and passive thermal control.
- (b) Power analysis to identify peak and average power for all scenarios.
- (c) Mass properties analysis for the spacecraft throughout all mission phases.
- (d) Aerodynamic and aerothermal analysis.
- (e) Micrometeoroid and orbital debris impact/penetration analysis.
- (f) Communications coverage analysis.
- (g) Propulsion system analysis including propellant margins and on-orbit maneuverability.
- (h) Guidance, navigation and control analysis including rendezvous, proximity operations, and mating.
- (i) Thermal analysis for safing upon landing.
- (j) Delta-v budget for CEV
- (k) Deceleration/ landing system performance.
- (l) EMI/EMC analysis.
- (m) Descent trajectory analysis including any orbital phasing to increase landing cross-range, heating, aerodynamic loads, stability, accelerations and safe disposal of expendable elements.
- (n) Attitude determination and navigation state accuracy analysis.
- (o) Radiation assessment for crew health and spacecraft performance.
- (p) CEV performance assessment when subjected to environments.
- (q) Thermal Protection System integrity.
- (r) Human factors assessment for all CEV crew operations including crew time estimation and habitability assessments.
- (s) Analyses of flight and ground operational attributes to include a description of how the systems products serve the operators (e.g., flight crew, ground operations, and flight operations).
- (t) Crew escape system performance.
- (u) CEV computer resource estimation.
- (v) Internal volume allocation of the CEV cabin.
- (w) Consumable analysis including CEV spacecraft systems, food and drinking water.
- (x) Flammability, toxic off gassing and materials compatibility analysis.
- (y) Spacecraft margins as required by the CEV Margin Management Plan

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1. Requirements traceability (including decision support and requirements validation data) must be maintained within the requirements database.

13.5 **MAINTENANCE:** Changes shall be identified and complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-011
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/20/2005
5. **PAGE:** 1
6. **TITLE:** Integrated Logistics Support Plan
7. **DESCRIPTION/USE:**  
To describe support concepts, requirements and plans to include maintenance and logistics for CEV Project supportability. This includes life cycle plans for design-in-supportability, hardware processing and definition of logistics support resources.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
The following document(s) may be used as guidance:
  - CXP-02011: Constellation Systems Supportability Strategy
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.6.  
Referenced from SOW Paragraph(s): 9.2  
Related DRD(s): CEV-O-002, CEV-S-011, CEV-T-012, CEV-T-014
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Integrated Logistics Support Plan (ILSP) identifies the maintenance and support concepts and the requirements and plans for implementing these concepts for the CEV's life cycle. When the Contractor has specified delivery of another plan that contains aspects of the required information, the ILSP should summarize these aspects and refer to the other plan.
- 13.2 **APPLICABLE DOCUMENTS:**  
NPR 6000.1G: Requirements for Packaging, Handling, and Transportation of Aeronautical and Space Systems, Equipment, and Associated Components
- 13.3 **CONTENTS:**  
The Integrated Logistics Support Plan (ILSP) shall include as a minimum the following elements as separate appendixes:
  1. Supportability management and interface with other disciplines, such as reliability maintainability, and design engineering.
  2. Maintenance and support concept:
    - (a) Maintenance levels and maintenance sites.
    - (b) Maintenance functions per level.
    - (c) Maintenance environment (i.e., organization and resources available at each level/site).
    - (d) Repair/sparing policy.
    - (e) Maintenance item and line replaceable unit (LRU/ORU) selection criteria.
    - (f) Storage Requirements (long and short term, if different)
  3. Facility plan.

4. Test and support equipment plan, including ground support equipment (GSE).
  5. Supply support plan.
  6. Packaging, Handling, and Transportation documentation as required by NPR 6000.1G
  7. Provisioning plans.
    - (a) Approach for determining the types and quantities of spares, repair parts, and materials.
    - (b) Phasing and schedule to procure using spares acquisition integrated with production and meeting availability, supportability, and lifecycle cost requirements.
    - (c) Process for conducting provisioning conferences to review contractor procurements.
  8. Shop and lab support plans.
  9. Standardization/commonality policy.
  10. Technical data/database documentation criteria and management.
  11. Computer resources plan.
  12. Contingency plan.
  13. Obsolescence plan.
  14. Post-production support (i.e., logistics, maintenance, and sustaining engineering)
  15. Depot/manufacturing facility certification plan.
  16. Logistics Management System (LMS) implementation strategy. The LMS strategy shall define the integration of the CEV LMS within the Constellations Systems LMS and address how the CEV crew will interact with the LMS.
- 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.
- 13.5 **MAINTENANCE:** Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

1 PROGRAM: CEV 2 DRD NO.: CEV-T-012  
3 DATA TYPE: 2 4 DATE REVISED: 12/21/2005  
5 PAGE: 1

6 TITLE: Logistics Support Analysis

7 DESCRIPTION/USE:  
To document the results of the analysis performed to support the design-for-supportability process and to determine the total resources necessary to support the maintenance of the system over its operational life cycle. Data generated will be used as input into other system analyses such as cost, recommended spare parts lists and maintenance procedures development.

8 DISTRIBUTION: As determined by the Contracting Officer.

9 INITIAL SUBMISSION: Per Data Requirements Matrix

10 SUBMISSION FREQUENCY: Per Data Requirements Matrix

11 REMARKS:  
The following document(s) may be used as guidance:  
• CXP-02011: Constellation Systems Supportability Strategy

12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 2.1.6.  
Referenced from SOW Paragraph(s): 6.5, 9.2  
Related DRD(s): CEV-S-011, CEV-T-011, CEV-T-014

13 DATA PREPARATION INFORMATION:

13.1 SCOPE:  
The Logistics Support Analysis will address the total support resources required for the maintenance of the CEV System over its operational life.

13.2 APPLICABLE DOCUMENTS:

13.3 CONTENTS:  
The Logistics Support Analysis shall provide a Logistics Support Analysis Records (LSAR) database with information under the following categories:  
1. Operational Requirements Analysis.  
2. Functional Analysis/Allocation.  
3. Repair Level Analysis.  
4. Maintenance Task Analysis.  
5. Test and Support Equipment Requirements, including Ground Support Equipment (GSE).  
(a) Concise description of each end item.  
(b) Short description of the general requirements to be met (i.e., purpose, function, unique requirements, usage location, if known, and safety category).  
(c) Identification of those end items that are common for use with other launch and test sites.  
(d) National Stock Number (NSN) if already cataloged:  
\* Government Furnished Equipment (GFE).  
\* Modified GFE.  
\* Commercial.  
\* Modified commercial.  
\* Manufacture (new).

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6. Facility Requirements.
  7. Manpower, Personnel and Training Requirements. Logistics support analysis shall include contractor labor by function.
  8. Provisioning and Supply Support Analysis.
  9. Standardization/commonality analysis.
  10. Recommended Spares Parts List (RSPL): The RSPL submittals shall include statement of scope, selection criteria, and groundrules.
  11. Packaging, Handling, Storage and Transportation (PHS&T) requirements.
  12. Technical data, documentation and database requirements.
  13. Post-Production Support
  14. Logistics Management System (LMS) data elements such as: Part Number, Serial Number, CAGE Code, Part Name, Acronym, System, Subsystem, Length, Width, Height, Diameter, Mass
- 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.
- 13.5 **MAINTENANCE:** Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-013
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/20/2005
5. **PAGE:** 1
6. **TITLE:** Launch Site CEV Propellants, Fluids, and Gases Forecast
7. **DESCRIPTION/USE:**  
To provide input to the Launch site fluids budget requirements for propellants and to forecast liquids, gases, and chemical requirements to be used in CEV processing.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
See Content for the types of propellants, liquids, gases, and chemicals that may be provided by the launch site. Form can be found at '<http://propellants.ksc.nasa.gov/forecast.htm>'.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.6.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The launch site CEV Propellants, Fluids, and Gases Forecast provide inputs to the KSC fluids budget requirements for propellants, cryogenics, fluids, gases, bulk chemicals, and commodities required for use at the launch site.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The launch site CEV Propellants, Fluids, and Gases Forecast provide forecasted requirements annually for a three-year period for all propellants, fluids and gases required by the Contractor in support of CEV processing. Forecasts shall be based upon documented CEV requirements, past experience, anticipated test requirements and scheduled launch requirements with consideration given to such factors as lead time and storage losses.

Forecast defines requirements for the next three (3) year period, starting on July 1. The first six-month period is forecasted monthly, periods thereafter by quarter

Types of Propellants, Liquids, Gases, and Chemicals provided by KSC

Classification:	Description:
Cryogens	Air, Liquid
	Argon, Liquid
	Helium, Liquid
	Hydrogen Liquid
	Neon, Liquid
	Nitrogen, Liquid



Hypergols	Oxygen, Liquid Hydrazine Hydrogen Peroxide Monomethylhydrazine Nitrogen Tetroxide Aerozine-50
Compressed Gas	Nitric Oxide Air Helium Hydrogen Nitrogen Oxygen Gaseous Mixtures
Petroleum Fuels	JP-8/RP-1
Bulk Chemicals	Acids Alcohols Ammonia Bases Fire Extinguishing Agents Hydraulics Neutralizers Refrigerants Scrubber Solutions Solvents
Other Fluids	Water/Ethylene-Glycol Water Distilled/Hi Purity 5 Various Mixed Liquids/Gases Contaminated Fluids Hazardous Chemical Wastes Other as Negotiated

- 13.4 **FORMAT**: Data shall be submitted via NASA Form 558, or electronic equivalent per Section J-2 3.2.1.
- 13.5 **MAINTENANCE**: Forecasts shall be updated and submitted annually (April 15). In addition, supplemental forecasts shall be submitted at any time that significant additions or changes to previous forecasts become evident.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-014
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/20/2005
5. **PAGE:** 1
6. **TITLE:** Supportability Data Package
7. **DESCRIPTION/USE:**

To provide supportability data for each configuration item. Supportability data is defined as any recorded information regardless of form or character (e.g., manuals, drawings) of a scientific or technical nature. Excluded are financial data or other related to contract administration. Supportability data is one of the principal elements of Integrated Logistics Support (ILS).
8. **DISTRIBUTION:** As determined by the Contracting Officer
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**

The contractor is responsible for the establishment, implementation, and delivery of the necessary documentation and capabilities for the successful logistical support for the CEV. NASA may transition the management and execution to another organization and data supportive of this transition must be captured during the development and production phases.

The following document(s) may be used as guidance:

  - CXP-02011: Constellation Systems Supportability Strategy
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.6.  
Related DRD(s): CEV-T-011, CEV-T-012, CEV-T-039, CEV-T-040, CEV-T-088
13. **DATA PREPARATION INFORMATION:**
- 13.1. **SCOPE:**

The delivery of supportability data necessary for the long term, life cycle sustainment of CEV hardware including logistics support.

The Contractor shall identify and provide supportability data to logistically support flight and ground hardware for the program life cycle. Supportability data shall be delivered to support pre-launch/post-landing, in-flight, and ground operations. Supportability data shall be developed to support secondary servicing and re-procurement. The Contractor shall identify and provide imagery taken during manufacturing, test, integration, and closeout. The Contractor shall avoid any limitations or restrictions on NASA's right to use delivered supportability data.
- 13.2. **APPLICABLE DOCUMENTS:**
- 13.3. **CONTENTS:**

The submittals under this DRD shall include:

  1. Source Data and Documentation (SD&D) Index:  
Tables of source data provided for use in the preparation of maintenance procedures. Tables to be arranged by maintenance level of task being

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performed.

2. Illustrated Parts Breakdown (IPB):

Exploded views of flight hardware and support equipment depicting their assembly. The IPB will illustrate the level of maintenance identified within the Logistics Support Analysis (LSA) process.

3. Validation status report:

The validation status report provides the validation records and status summary for ILS applicable documents.

4. Maintenance tasks as documented in the Logistics Support Analysis Record (LSAR) database (Reference DRD CEV-T-012, Logistics Support Analysis):

LSAR database (LSA Control Number (LCN) & task code) will be referenced within the SD&D indexes. Using this as a guide, pertinent task data will be extracted for the use in preparation of maintenance instructions and in-flight maintenance procedures.

5. Engineering data such as drawings (as-built), illustrations, specifications, schematics (electrical, mechanical and fluid), and associated parts lists that depict hardware features and physical characteristics at the component level consistent with the maintenance concept for Line Replaceable Unit (LRU), Shop Replaceable Unit (SRU). Drawings, specifications, schematics, and other documentation shall be provided in its native file format. This information includes equipment dimensions, location, attaching hardware, interfaces, alignment features, nomenclature, markings/placarding, test points and etc.: Engineering data will be primarily generated by the hardware provider but other types such as government, military, commercial, and vendor documentation can also be utilized.

6. Imagery (photographic and video data) developed during the manufacture, assembly, checkout, and final close-out of flight hardware and Support Equipment (SE) to support on-orbit operations, ground processing and maintenance (Reference DRD CEV-T-088, CEV Imagery Plan/Imagery Deliverables):

Photographs to document CEV configuration to support maintenance procedures development and execution. Video is not required, but if the Contractor makes video of their hardware as normal course of business, access to the video is requested.

7. Acceptance Data Package (ADP) (Reference CEV-T-040, Acceptance Data Package):

ADP includes several types of data as defined in CEV contractual documentation.

8. Operations procedure source data including Operational Sequence Diagrams (OSD):

Element/system specific mission scenarios containing Functional Flows, Requirement Allocation Sheets, and Timelines.

9. Test procedures:

Test procedures used at the Contractor facility.

10. Commercial Off-The-Shelf (COTS) data and manuals

11. Plans/Analysis (Reference DRD CEV-T-012, Logistics Support Analysis): Repair Level Analysis (RLA), Maintenance Plans, Recommended Spare Parts Lists, warranty information, etc.

12. Depot Repair Procedures (DRP).

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13. Acceptance Test Procedures (ATP) (Reference CEV-T-039, Acceptance Test Procedures)

14. Manufacturing Documentation:

Manufacturing documentation in the form of hardware build and assembly integration and checkout records can be referenced within the SD&D indexes. This type of documentation would be primarily used for depot level procedures, but also could support ground processing of flight hardware and support equipment (SE). Also includes PRACA-type data.

13.4 FORMAT: Electronic format per Section J-2 2 3.2.1

13.5 MAINTENANCE: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

## DATA REQUIREMENTS DESCRIPTION (DRD)

1 PROGRAM: CEV 2 DRD NO.: CEV-T-015  
3 DATA TYPE: 1 4 DATE REVISED: 12/21/2005  
5 PAGE: 1  
6 TITLE: Master Verification Plan (MVP)  
7 DESCRIPTION/USE:  
The MVP documents the verification planning and implementation activities that will provide evidence that the CEV System meets the identified system, module, subsystem, and component requirements.  
8 DISTRIBUTION: As determined by the Contracting Officer.  
9 INITIAL SUBMISSION: Per Data Requirements Matrix  
10 SUBMISSION FREQUENCY: Per Data Requirements Matrix  
11 REMARKS:  
The following applicable documents: NASA-STD-5001 and NASA-STD-5002 apply to the static/strength test plan and dynamic test plan volumes only. The following document(s) may be used as guidance:  
• NASA-HDBK-7005: Dynamic Environmental Criteria  
12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 2.1.7.  
Referenced from SOW Paragraph(s): 6.1.4, 6.2, 6.2.1, 6.2.6, 6.2.7, 9.2  
Related DRD(s): CEV-T-052  
13 DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
The Master Verification Plan shall discuss all disciplines and activities required for the verification of deliverable hardware and software. The Master Verification Plan provides a thorough description of the approach and structure for implementing the verification program, as well as detailed descriptions of the planned verification activities for each requirement.  
13.2 APPLICABLE DOCUMENTS:  
CXP-02005: Constellation Master Verification Plan  
NASA-STD-5001: Structural Design and Test Factors of Safety for Space Flight Hardware  
NASA-STD-5002: Loads Analyses of Spacecraft and Payloads  
13.3 CONTENTS:  
The Master Verification Plan shall comply with the Constellation Master Verification Plan (CXP-02005). This plan shall define the verification planning and implementation activities that provide evidence that the system was built to meet design and performance requirements. Component, subsystem, module, and system testing shall be planned as an integrated program; i.e., test plans for an individual element shall be tailored to that element's operational requirements, considering all testing to be performed from development through System acceptance testing and integrated testing. These plans shall be subject to NASA approval and be configuration controlled in accordance with DRD CEV-M-003, Configuration Management Plan and Reports.

The Master Verification Plan shall define the verification and

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certification process for the design, functional, interface and specialty engineering requirements for CEV hardware and software at the end-to-end system, subsystem assembly and component levels including interface requirements with other Constellation elements and equipment

The verification program shall include the tests, demonstrations, analyses, and inspections required to meet Critical Items List (CIL) retention rationale and to control hazards.

The Master Verification Plan shall be organized to include system-level and subsystem-level verification discussions, to facilitate its distribution and review. Additionally, for each subsystem, a detailed overview of verification objectives, scope and extent of associated verification activities, including the verification configuration and its relationship to the flight configuration, will be defined at the module, integrated subsystem, subsystem assembly, and major components levels.

The Master Verification Plan shall include verification requirements that are specific to performance and operational parameters. These Verification requirements will be satisfied using the methods of test, analysis, inspection or demonstration for compliance.

In addition to demonstration, analysis and inspection, the Master Verification Plan shall address the following types of testing: (1) Ground Tests, (2) Flight Tests, (3) Development Tests, (4) Item Tests, (5) Functional Tests, (6) Integration Tests, (7) Hardware-in-the-loop (HWIL) Tests, (8) Software-in-the-loop (SIL) Tests, (9) Human-in-the-loop Tests, (10) Nonoperating Environment Tests, (11) Operating Conditions & Environment Tests, (12) Acceptance Tests, and (13) Qualification Tests.

The Master Verification Plan shall include:

1. Overview of the Project's verification program (i.e., qualification/acceptance vs. protoflight, verification of spares, refurbishment/reverification/recertification plans).
2. Description of the Project's organizational structure for implementing the verification program (i.e., organization's involved in component vs. system tests, review and signoff authority for compliance data).
3. Verification matrix that clearly documents the verification method or methods employed for each System level requirement and each allocated requirement. For each major test (i.e. formal verification, acceptance article, etc.), a test plan shall be submitted to NASA for approval and final signature authority. Test objectives shall be planned to verify compliance with the design and specified requirements of the items involved, including interfaces.
4. For each verification activity identified in the verification matrix, a detailed description of the activity including the verification configuration and its relationship to the flight configuration as well as the associated prerequisites, constraints, objectives, procedures, relevant environmental conditions, pass/fail criteria, and analysis models, if applicable. Verification requirements shall be individually defined for each component or assembly considering its function, complexity, redundancy, design, and maintenance requirements.
5. Acceptance tests ground-rules that assure Acceptance Test Procedures (ATPs) will demonstrate conformance to specification requirements and provide quality control assurance against workmanship or material deficiencies.
6. Ground-rules assuring qualification test (or demonstration) hardware and software test articles shall be of the same configuration and manufacturer, and be manufactured under the same production processes as the flight hardware and software, unless variances are approved formally by the contractors and NASA and adequately documented according to the test article supplier's established configuration management procedures.

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(a) Identification of selected software verification procedures and criteria across the life cycle (e.g., peer review procedures, inspection procedures, re-inspection criteria, testing procedures).

(b) Identification of selected software work products to be verified (e.g., peer reviews of requirements and test plans, peer reviews/inspections of critical code, testing code against requirements and design).

(c) Description of software verification environments that are to be established for the project (e.g., software testing environment, system testing environment, regression testing environment).

(d) Identification of where the actual software verification records and analysis of the results will be documented (e.g., test records, peer review records, inspection records), and where software verification corrective action will be documented.

7. Qualification re-verification analysis shall be required when any of the following occur:

(a) Design or manufacturing process changes have been made which affect function or reliability

(b) Inspection, test, mission change, or other data indicate that a more severe environment or operating condition exists than that to which the hardware/software was originally qualified

(c) Changes are made in procurement source

(d) Changes are made in specification, manufacturing processes or procurement sources for fluids or other materials used in processing or operating the hardware/software

(e) Software changes occur that affect requirements or flight software capabilities

(f) Based on the results of the analyses, re-verification type and scope shall be subject to government approval.

8. Retest for those activities in the Acceptance Phase will be required when any of the following occur:

(a) A previously mated and verified interface has been de-mated

(b) Modification, repair, replacement, or rework occurs after inspection or testing

(c) The article or material is subject to drift or degradation during storage or handling

(d) Software changes occur that affect requirements or flight software capabilities.

Based on the results of the analyses, re-verification type and scope shall be subject to government approval.

9. Functional compliance matrix that identifies all safety-critical functions and provides detailed descriptions of the associated verification methods(s) for each safety-critical function including the verification configuration and its relationship to the flight configuration, as well as the associated prerequisites, constraints, objectives, procedures, relevant environmental conditions, pass/fail criteria, and analysis models, if applicable.

10. A fault-tolerance diagram or matrix that demonstrates the design and functional compliance of the CEV System with the fault-tolerance requirements decomposed through the system, module, subsystem, and component levels.

11. Detailed time-correlated sequence of verification activities.

12. Description, planned usage, and certification plans of the support equipment, software, facilities, and tools necessary to execute the system verification activities.

13. Identification of the resources required to perform the required verification activities as well as resource owners and/or providers. These resources (e.g., facilities, software, simulators) include those that do not currently exist or existing resources that need to be upgraded.

14. Certification plans for ground systems (reference SOW section 9).

Additional volumes shall be added to the Master Verification Plan for the following special tests: static/strength test plan and dynamic test plan. The following information shall be included in the plan volume:

1. Description and sketches of the structure, all allowables which will be used for strength analysis, and a description of manufacturing processes that are used.
2. Identification of materials that are used, and boundary conditions, to the flight article. Explain and provide justification as to why any differences are acceptable for static test loads and their comparison to the design/flight loads.
3. Comparison of the test article, including test setup, including load application techniques, load magnitude, locations, instrumentation layout, and data recording system.
4. Discuss the derivation of the static math model.
5. Provide the pretest configuration to predict critical deflections, and stresses of the test measurement locations.
6. Planned scans for vehicle handling and transportation.
7. Description of special materials (i.e., composites, beryllium, and glass) and the corresponding measures which will be taken to verify their strength and reliability.

The following information shall be included in the dynamic test plan volume:

1. Description of test article in relation to the flight article. Include a summary of dummy masses that will not be included in test and components that will not be included in test.
2. Comparison of test and flight article mass properties.
3. Description and sketches of test setup including:
  - (a) Description and sketches of the instrumentation location on the test article and test fixture.
  - (b) Description of and rationale for selection of excitation method, levels, and application points.
4. Description of test article boundary conditions:
  - (a) For the test article support structure, provide evidence that the support structure does not participate in the test frequency range. Otherwise, describe how a 'test verified' model of the support structure will be obtained, as well as how it will be instrumented during testing.
  - (b) For 'free-free' test, describe how the interface modes will be verified. Describe the suspension system and predicted suspension modes.
5. Summary of steps which will be taken to investigate linearity.
6. Derivation of test specimen math model which will be used for correlation analysis.
7. Summary of pretest analysis and results including:
  - (a) Identification of the target modes and the rationale for their selection.
  - (b) Description and plots of the target mode shapes.
  - (c) Assessment of the test fixture/test article interaction including work done in correlating the test fixture itself.
  - (d) Comparison of the test article modes installed in the test fixture with the flight article modes.
  - (e) Evaluation of the instrumentation locations including a comparison of the full model modes to the modes from the model reduced to the instrumentation locations (cross-orthogonality comparison).
8. Description of the planned correlation analysis.
9. Describe plans for vehicle handling and transportation.



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13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

## DATA REQUIREMENTS DESCRIPTION (DRD)

1 PROGRAM: CEV 2 DRD NO.: CEV-T-016  
3 DATA TYPE: 2 4 DATE REVISED: 12/21/2005  
5 PAGE: 1  
6 TITLE: Certification Plans  
7 DESCRIPTION/USE:  
To document the plans for certifying the capability of equipment and facilities. Each certification plan describes the work to be performed to create the certified capability baseline for the equipment or facility it addresses.  
8 DISTRIBUTION: As determined by the Contracting Officer  
9 INITIAL SUBMISSION: Per Data Requirements Matrix  
10 SUBMISSION FREQUENCY: Per Data Requirements Matrix  
11 REMARKS:  
12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 2.1.7.  
13 DATA PREPARATION INFORMATION:  
13 1 SCOPE:  
A Certification Plan provides the detailed description of equipment or facility certification requirements, work plans, source and product documentation, and data to be supplied for establishing an as-certified baseline and informing subsequent integration, operation, and problem resolution activities.  
13 2 APPLICABLE DOCUMENTS:  
CXP-02005: Constellation Master Verification Plan  
13 3 CONTENTS:  
A Certification Plan shall include the following:  
a. A description of the equipment or facility covered by the plan. For assemblies, include a list of items integrated into the assembly which are individually certified.  
b. A description of the characteristics, capabilities, and limits that will be addressed in the certification record(s) produced in accordance with the plan.  
c. A list of requirements and standards (including verification matrix) that will be fully or partially verified using the plan.  
d. Detailed requirements for tests, analyses, etc., that will be performed to verify the design's compliance with specifications, qualify the design for its intended purpose, and create the certification records needed to baseline the certified capabilities and limits of the equipment or facility.  
e. A list of accessible, version-controlled, engineering data or reports used to derive, define, or predict the detailed functions, performance ranges, service (non-operating, operating, and test) environments and operating behaviors of the design that will be certified by the plan.  
f. A list and description of test articles, support equipment, software, facilities, or models to be used.  
g. The safety and quality provisions applied in the plan.

h. An undated Program Evaluation and Review Technique (PERT) schedule for implementing the plan identifying critical path and any prerequisites, constraints or dependencies in the plan.

- 134 FORMAT: Electronic format per Section J-2 2.3.2 1. incorporated by change page or complete
- 135 MAINTENANCE: Changes shall be incorporated by change page or complete reissue.

## DATA REQUIREMENTS DESCRIPTION (DRD)

1 PROGRAM: CEV 2 DRD NO.: CEV-T-017  
3 DATA TYPE: 1 4 DATE REVISED: 12/21/2005  
5 PAGE: 1  
6 TITLE: Certification Data Package  
7 DESCRIPTION/USE:  
To provide the evidence and audit trail required by NASA to establish an as-certified baseline for the CEV and it's components, and to confirm that verification activities indicate all requirements were met.  
8 DISTRIBUTION: As determined by the Contracting Officer.  
9 INITIAL SUBMISSION: Per Data Requirements Matrix  
10 SUBMISSION FREQUENCY: Per Data Requirements Matrix  
11 REMARKS:  
Certification data are produced in accordance with the certification plans to create a record of qualification and integration activities that together create a certified capability description.  
12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 2.1.7.  
Referenced from SOW Paragraph(s): 6.1.4, 6.2, 6.2.1, 6.2.1.1, 9.2  
Related DRD(s): CEV-T-018  
13 DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
The Certification Data Package contains the elements of documentation required to establish that all requirements have been met by the integrated systems, hardware, and/or software.  
13.2 APPLICABLE DOCUMENTS:  
13.3 CONTENTS:  
A Certification Data Package shall contain the following:  
1. Current version of the spacecraft system, module, subsystem, or component requirements document for the integrated system, hardware, or software that is being certified.  
2. Current version of the certification plan for the spacecraft system, module, subsystem, or component.  
3. Verification compliance report, including the verification matrix mapped to all verification data. This report shall include:  
(a) Qualification report, including test, analysis, inspection, and demonstration reports..  
(b) Acceptance report for the qualification unit or the first flight unit.  
(c) Summary of and references to Failure Mode and Effects Analysis (FMEA), hazard analysis and controls reports, and Critical Items List (CIL) rationale for retention, including residual risk information..  
(d) List of approved operational controls  
(e) Verification tracking log

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4. A certification data summary, which contains the following:
    - (a) Engineering drawings
    - (b) Operational information and relevant documentation
    - (c) Materials information
    - (d) Electrical information
    - (e) Electromagnetic compatibility information
    - (f) EEE parts information
    - (g) Natural and induced environment reports
    - (h) Software/firmware Version Description Document (VDD)
  5. Manufacturing and acceptance testing procedures and processes now qualified
  6. Waivers, deviations, non-conformance reports and problem closure reports
  7. Limits on run time, idle time, age, cycle, or storage shelf life
- 134 **FORMAT:** Electronic format per Section J-2 2.3.2.1.
- 135 **MAINTENANCE:** Contractor-proposed changes to this document shall be submitted to NASA for approval. Changes to the Certification Data Package shall be made with a Certification Approval Request detailing the portions of the current version that is amended, revised, or replaced with new certification data.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-018
3. **DATA TYPE:** 1
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Certification Approval Request
7. **DESCRIPTION/USE:**  
A request for NASA approval of the certification records that establish, amend, revise, or replace the certified capability baseline for equipment or facilities.
8. **DISTRIBUTION:** As determined by the Contracting Officer
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
A Certification Approval Request (CAR) is delivered in support of design certification milestone.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2 1.7.  
Related DRD(s): CEV-T-017
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
A CAR may cover one or more equipment or facility items at the levels of assembly covered by the certified capability baseline description and the supporting certification records delivered in accordance with CEV-T-017.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
A CAR provides a request for NASA approval of the certified capability baseline - the detailed description and recognized definition of equipment capabilities, limits, and constraints for the purposes of establishing flight rules/crew procedures, documenting and resolving non-conformances, and sustaining equipment design. Qualification margins are not be intruded upon by production hardware in service and should not be reflected by the certified baseline capability.  
  
A CAR shall include:
  1. A definition of the equipment or facility covered by the request, including
    - a. Supplier
    - b. Part numbers
    - c. Drawing references
    - d. Manufacturing process and standards, and acceptance testing procedure references
    - e. Used-on location(s) (next higher assemblies)
  2. A detailed description of the performance capabilities, behaviors, limits and constraints being certified, including
    - a. Operational signatures
    - b. Order of operations requirements
    - c. Limits on operating time, cycles, age or shelf life.Capabilities, limits, behaviors, etc. shall be expressed in terms

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of measurable, observable indications available to operators and data evaluators.

3. A list of the Certification Data Packages (CEV-T-017) supporting the CAR

4. Reference to the Certification Plan(s) implemented for this certification

134 FORMAT: Electronic format per Section J-2 2.3.2.1.

135 MAINTENANCE: Changes shall be incorporated by submittal of a "delta" certification approval request in accordance with this DRD.

1 **PROGRAM:** CEV 2 **DRD NO.:** CEV-T-019  
3 **DATA TYPE:** 2 4 **DATE REVISED:** 12/21/2005  
5 **PAGE:** 1  
6 **TITLE:** Materials and Processes Selection, Implementation, and Control Plan  
7 **DESCRIPTION/USE:**  
To define the objectives, procedures, logic, and management controls of the hardware developer's (i.e., contractor's) Materials and Processes (M&P) selection, implementation, verification, and control program; and the hardware developer's interfaces with the procuring activity necessary in the operation of this Plan. In addition, this plan shall be used to tailor the requirements used for specific programs/projects by comparing and contrasting the hardware developer's requirements to the JSC 49774 requirements and its applicable documents. This will be done by constructing a matrix of applicable paragraphs and paragraphs that are not applicable. The final tailoring of requirements shall be documented in this plan to provide the degree of conformance and the method of implementation for each requirement identified in JSC 49774. Tailoring also includes using existing or previously developed Contractor processes and standards as a submittal of the various required plans.  
8 **DISTRIBUTION:** As determined by the Contracting Officer.  
9 **INITIAL SUBMISSION:** Per Data Requirements Matrix  
10 **SUBMISSION FREQUENCY:** Per Data Requirements Matrix  
11 **REMARKS:**  
12 **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.9.1.  
Related DRD(s): CEV-S-001, CEV-T-020  
13 **DATA PREPARATION INFORMATION:**  
13.1 **SCOPE:**  
The Materials and Processes Selection, Implementation, and Control Plan defines the objectives, procedures, logic, and management controls for materials and processes selection, implementation, verification, and control. In addition, this plan shall be used to tailor the requirements identified in JSC 49774.  
13.2 **APPLICABLE DOCUMENTS:**  
JSC 49774A: Standard Manned Spacecraft Requirements for Materials and Processes (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)  
13.3 **CONTENTS:**  
The plan shall describe the hardware developer's activities involved in the identification, evaluation, documentation, and reporting of materials and processes usage in space flight hardware, support hardware and ground support equipment. The necessary interfaces with procuring activity in the operation of this plan shall be defined. The method for materials control and verification of subcontractors and vendors shall be included in the hardware developer's plan. As a minimum and as applicable, the plan shall address the following:



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1. Conformance - The plan shall address each applicable paragraph of JSC 49774 and describe the method of implementation and degree of conformance for each applicable requirement. If tailoring of the requirements is planned or necessary, the alternate approaches to JSC 49774 may be submitted in this plan, which meet or exceed the stated requirements. This tailoring approach will allow for NASA approval of alternate requirements.
2. Hardware Developer's Organization - Authority shall be assigned to an individual or group who shall be responsible for review and approval of all M&P specified prior to release of engineering documentation.
3. Materials and Processes Identification - Identification and documentation of the M&P used, both in the original design and in any changes.
4. Usage Evaluation - The comparison of the Contractor's materials selection rationale to the requirements as specified in JSC 49774.
5. Testing - Logic, procedures and data documentation for any proposed test program to support materials screening and verification testing. Any material/process testing to be performed by the hardware developer shall require prior NASA approval.
6. Material Usage Agreement (MUA) Procedures - Logic, procedures and documentation involved in documenting and approving materials/processes as indicated in JSC 49774 shall be defined, including those that do not meet the established requirements, but are proposed for use due to lack of replacement materials/processes or other considerations.
7. New Technology - Identify areas of new test technology or technique improvement for consideration.
8. Material Design Properties - The plan shall contain the philosophy describing how material properties will be determined, and if those properties do not exist, how the material properties will be developed including, but not limited to the statistical approaches to be employed.
9. Approved Materials List (AML) - The plan shall contain an Approved Materials List from which all materials, including fasteners, will be selected.
10. Approved Processes List (APL) - The plan shall contain an Approved Processes List from which all processes will be selected.
11. Corrosion Prevention, Control, and Protective Finish Plan - The plan shall contain a corrosion prevention, control and protective finish plan which addresses the following as a minimum:
  - (a) Environmental corrosion prevention and control measures for all project components, including definition of all environments, test and verification requirements.
  - (b) Selection methodology with supporting data for the selection of M&P used in corrosion prevention and control.
  - (c) Finish specifications, delineating the protective finishes, including cleaning and surface treatment, shall be developed and available for review by NASA.
  - (d) Method of implementation and degree of conformance for each applicable paragraph of the guideline MSFC-SPEC-250A.
12. Forging Plan - The plan shall contain a forging plan which shows the locations and numbers of specimens to be excised from the first production equivalent size forging, including production forging verification and control measures. In the event of forging process changes, the plan shall include supporting rationale and/or tests to demonstrate the required design material properties and grain flow patterns at control areas.
13. Casting Plan - The plan shall contain a casting plan in accordance with JSC 49774 which shows locations and numbers of specimens to be excised from the first production equivalent size casting, including production casting verification and control measures. In the event of casting process changes, the plan shall include supporting rationale and/or tests to demonstrate the required design material properties and grain size at control areas.

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14. Adhesive Control and Operator Certification Plan - The plan shall contain an adhesive control plan and adhesive bonding operator certification plan as described in MSFC-SPEC-445A.
15. Review Procedures - Assessment and status of materials and processes to permit evaluation of a given design or configuration at hardware milestone reviews.
- 134 **FORMAT**: Electronic format per Section J-2 2.3.2.1.
- 135 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

- 1     **PROGRAM:** CEV
- 2     **DRD NO.:** CEV-T-020
- 3     **DATA TYPE:** 1/2
- 4     **DATE REVISED:** 12/21/2005
- 5     **PAGE:** 1
- 6     **TITLE:** Materials Usage Agreements (MUA)
- 7     **DESCRIPTION/USE:**  
MUAs shall be submitted for all materials and processes that are technically acceptable (because they do not affect hardware reliability and vehicle safety) but do not meet the technical requirements of JSC 49774A, as implemented by the approved Materials and Processes Selection, Implementation, and Control Plan (DRD CEV-T-019).
- 8     **DISTRIBUTION:** As determined by the Contracting Officer.
- 9     **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10    **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11    **REMARKS:**  
The DRD type is dependent on the nature of the MUA being submitted. For Category I and II MUAs the type shall be 1. For Category III MUAs the type shall be 2.
- 12    **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.9.1.  
Related DRD(s): CEV-T-019, CEV-T-022
- 13    **DATA PREPARATION INFORMATION:**
- 13.1   **SCOPE:**  
MUAs shall be submitted as described below.  
  
Category I MUAs - Category I MUAs are those that involve material/processes usage that could affect the safety of the mission, crew, or vehicle or affect the mission success, but must be used for functional reasons. Approval by the responsible NASA Materials and Processes organization and the NASA Program/Project Office shall be required.  
  
Category II MUAs - Category II MUAs are those that involve material/processes usage that fails a screening of Material and Processes requirements and is not considered a hazard in its use application but for which no Category III rationale code exists. Approval by the responsible NASA Materials and Processes organization shall be required.  
  
Category III MUAs - Category III MUAs are those that involve materials or processes that have not been shown to meet these requirements but have an approved rationale code listed in Appendix D of JSC 49774A. They are evaluated and determined to be acceptable at the configuration/part level. Category III MUAs shall be reported in the Materials Identification and Usage List (MIUL, DRD CEV-T-022) system or electronic data system utilizing the approved rationale codes in Appendix D. A key may be provided to correlate contractor Category III MUA database codes to the codes in Appendix D. No MUA form is submitted.  
  
MUAs shall be revised and resubmitted whenever design modifications affect the part numbers identified on the MUA or the MUA rationale.

13.2 **APPLICABLE DOCUMENTS:**

JSC 49774A: Standard Manned Spacecraft Requirements for Materials and Processes (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)  
MSFC-STD-3029: Guidelines for the Selection of Metallic Materials for Stress Corrosion Cracking Resistance in Sodium Chloride Environments

13.3 **CONTENTS:**

The MUA package shall include all technical information required to justify the application. MUAs for stress corrosion shall include a Stress Corrosion Cracking Evaluation Form per MSFC-STD-3029 (see JSC 49774A) and a stress analysis.

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1. A sample MUA form is provided in JSC 49774A; however, Contractor format is acceptable. The complete MUA package shall be provided in Adobe PDF searchable format; the MUA data shall also be provided in a format that is compatible with the NASA Materials and Processes Technical Information System (MAPTIS) database. The MUA data shall be delivered to ICE in accordance with Appendix 2.

13.5 **MAINTENANCE:** Contractor updates to the Category I and Category II MUAs shall be submitted to NASA for approval. Complete re-issue of the MUA is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-021
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Contamination Control Plan (CCP)
7. **DESCRIPTION/USE:**  
The contamination control plan defines implementation measures to control contamination of flight hardware/GSE and fluid systems during manufacturing, assembly, test, transportation, launch site processing, during the mission and post-flight refurbishment.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.9.1.  
Related DRD(s): CEV-S-001
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The contamination control plan shall include:
  - a. A Foreign Object Debris (FOD) control plan to prevent damage to flight hardware/GSE and injury to the flight and ground crews by FOD during manufacture, assembly, test, transportation, launch site processing, operation, repair, modification, refurbishment and maintenance. The FOD prevention program shall conform to NAS 412, Foreign Object Damage/ Foreign Object Debris (FOD) Prevention, as specified by JSC 49774A.
  - b. Definition of cleanliness level acceptance limits and verification methods for fluid systems, for general CEV flight hardware and GSE, internal and external surfaces, and airborne particulate. The plan shall also contain a list identifying all system fluids, together with the fluid specifications (for procurement or custom mixing) and the required cleanliness levels for the fluid system. Gases are included under fluid systems.
- 13.2 **APPLICABLE DOCUMENTS:**  
JSC 49774A: Standard Manned Spacecraft Requirements for Materials and Processes (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)  
NAS 412: Foreign Object Damage/ Foreign Object Debris (FOD) Prevention
- 13.3 **CONTENTS:**  
The CCP shall include:
  1. The FOD control plan.  
The FOD Control Plan shall address the following elements:
    - (a) Identification of probable FOD sources
    - (b) Early design considerations for FOD prevention, resistance to damage,

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foreign object entrapment, etc.

(c) Manufacturing planning for minimizing FOD generation and cleaning up whatever FOD is generated

(d) FOD control methods

(e) FOD Awareness and Prevention Training

(f) Metrics - Measuring techniques for analysis, trending, and feedback

(g) Incident investigation/reporting, lessons learned

(h) Awareness/Employee Feedback

(i) Updates to plan based on results of Metric and lessons learned

2. Cleanliness level acceptance limits definition and verification methods.

The document shall define cleanliness level acceptance limits and verification methods for fluid systems, for general CEV flight hardware and GSE, internal and external surfaces, and airborne particulate. The document shall also include a list identifying all system fluids, together with the fluid specifications (for procurement or custom mixing) and the required cleanliness levels for the fluid system. Gases are included under fluid systems. Update document as required based on any updated limits, verification methods, flight hardware changes, GSE changes and environmental changes.

13.4 **FORMAT** Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-022
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/19/2005
5. **PAGE:** 1
6. **TITLE:** Materials Identification and Usage List (MIUL)
7. **DESCRIPTION/USE:**  
The MIUL is an electronic searchable parts list or separate electronic searchable materials identification and usage list. The MIUL identifies all Material and Processes (M&P) usages contained in the end item, excluding piece part electronics, for evaluation of the acceptability of M&P selected and utilized.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.9.1.  
Related DRD(s): CEV-T-020
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
Materials and processes usage shall be documented in an electronic searchable parts list or separate electronic searchable Materials Identification and Usage List (MIUL). The procedures and formats for documentation of materials and processes usage will depend upon specific hardware but shall cover the final design. The system used shall be an integral part of the engineering configuration control/release system. A copy of the stored data shall be provided to NASA in a form compatible with the Materials and Processes Technical Information System (MAPTIS).
- 13.2 **APPLICABLE DOCUMENTS:**  
JSC 49774A: Standard Manned Spacecraft Requirements for Materials and Processes (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)
- 13.3 **CONTENTS:**  
The parts list or MIUL shall identify the following applicable information:
  - Detail drawing and dash number
  - Next assembly and dash number
  - Change letter designation
  - Drawing source (contractor or vendor)
  - Material form
  - Material manufacturer
  - Material manufacturer's designation
  - Material specification
  - Process specification
  - Environment
  - Weight
  - Material code

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- Standard/commercial part number
  - Contractor
  - System
  - Subsystem
  - Maximum temperature
  - Minimum temperature
  - Fluid type
  - Surface Area
  - Associate contractor number
  - Project
  - Document title
  - Criticality
  - Line number
  - Overall evaluation
  - Overall Configuration test
  - Maximum pressure
  - Minimum pressure
  - Test MUA Document
  - Cure codes
- 13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1. However, Contractor format for electronic submittal of MIUL data shall be compatible with the NASA Materials and Processes Technical Information System (MAPTIS) database. MIUL data shall be delivered to ICE in accordance with Appendix 2.
- 13.5 **MAINTENANCE**: Contractor updates to the MIUL shall be submitted to NASA for approval. Complete re-issue of the document is not required.



**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-023
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Nondestructive Evaluation Plan
7. **DESCRIPTION/USE:**  
The Nondestructive Evaluation (NDE) plan shall address the NDE requirements necessary to assure the health and integrity of the CEV System including Flight and GSE hardware throughout its life cycle. This plan shall identify all Nondestructive Evaluation (NDE) standards employed in the inspection of materials.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.9.1.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The NDE Plan shall describe the process for establishment, implementation, execution and control of NDE. The plan shall meet the intent of MIL-HDBK-6870A, Inspection Program Requirements, Nondestructive for Aircraft and Missile Materials and Parts and NASA-STD-5009, Nondestructive Evaluation Requirements for Fracture Control Programs as specified by JSC 49774A.
- 13.2 **APPLICABLE DOCUMENTS:**  
JSC 49774A: Standard Manned Spacecraft Requirements for Materials and Processes (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)  
MIL-HDBK-6870A: Inspection Program Requirements Nondestructive for Aircraft and Missile Materials and Parts  
NASA-STD-5007: General Fracture Control Requirements for Manned Space Flight Systems  
NASA-STD-5009: Nondestructive Evaluation Requirements for Fracture Control Programs
- 13.3 **CONTENTS:**  
13.3.1 NDE Standards: The NDE plan shall address the selection and the order of precedence of applicable Government, Industry and prime contractor NDE specifications and standards and how the requirements contained therein are implemented through internal procedures and how-to documents. The oversight of subcontractor implementation and flow down of the NDE requirements shall also be addressed. The plan shall address commonly used aerospace industry NDE methods including, but not limited to, dye penetrant, radiographic (film radiography, digital radiography, computed tomography), ultrasonic, neutron radiography, magnetic particle, eddy current (including conductivity measurement), infrared thermography, acoustic emission, leak detection, and visual inspection. Other NDE related standards identified in the NDE plan shall include, but

not be limited to, lot sampling procedures, personnel qualification and certification, etc. The plan shall reject be approved by the specifications and standards for the CEV appropriate government authority.

Design: The NDE plan shall define the processes to assure that all parts are inspected. The inspection requirements and to inspected shall be identified on the areas or zones of the part so that the operations and maintenance drawing. The plan shall review the design of CEV hardware requirements be integrated.

13.3.3 Part Classification: The plan shall address appropriate flight hardware and GSE per hardware and parts identified as Fracture Critical and NASA-STD-5007, per DRD CEV-T-069, Fracture Control Plan. shall be documented.

13.3.4 NDE Sensitivity Levels: NDE sensitivity levels shall be classified as Standard NDE, Special NDE, Custom NDE and Visual Inspection in the NDE plan. The plan shall establish critical initial flaw size for Standard NDE for each material grouping of CEV hardware in compliance with NASA-STD-5009 where applicable. The plan shall establish procedures for defining NDE acceptance criteria for each of the sensitivity levels and identify organizations and their responsibilities in establishing NDE acceptance criteria, NDE drawing call outs, NDE Operations and Life Cycle Maintenance criteria. Note: Custom sensitivity level refers to an NDE sensitivity level that is not covered under the other three NDE sensitivity levels and is applicable to non-fracture critical parts.

13.3.5 NDE Acceptance Criteria: The plan shall address how NDE acceptance criteria are determined and implemented for each sensitivity level. The plan shall require rejection of any cracklike flaw irrespective of the sensitivity level of the inspection. All cracklike indications shall be dispositioned by Material Review Process. The plan shall address how significant flaw indications, irrespective of acceptance criteria, will be addressed.

13.3.6 Minimum NDE Acceptance Requirements for Manufacturing: The plan shall establish the minimum NDE acceptance requirements as defined by material type, form, class of part, NDE sensitivity level, methods of inspection (dye penetrant, ultrasonic etc.), sampling frequency, NDE inspection coverage (e.g. 100% surface area, selected area etc.), NDE inspection point within part manufacturing sequence (before or after welding, heat treating) for all manufactured parts.

13.3.7 NDE Sequencing during Manufacturing Planning: The NDE plan shall identify the process used to ensure that NDE inspection requirements are properly defined and are sequenced in the specific manufacturing process to optimize inspection reliability before processes are performed that may significantly reduce flaw detection capability. The requirements for etching of metal parts prior to penetrant inspection shall be specifically addressed in the plan.

13.3.8 NDE Material Compatibility: The plan shall identify applicable standards to ensure compatibility of NDE materials and processes with CEV hardware, especially liquid oxygen systems.

13.3.9 Fracture Critical Parts: The Plan shall address how the listing of all Fracture Critical parts created per DRD CEV-T-069, Fracture Control Plan, will be integrated with NDE requirements. The plan shall require demonstration of Special NDE inspection reliability (90% probability with 95% confidence) when the inspection method differs from standard NDE

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methods described in NASA-STD-5009 or the flaws to be detected are smaller than the standard level flaw size of NASA-STD-5009.

13.3.10 NDE during Operations and Life Cycle Maintenance (O & M): The NDE plan shall address the NDE requirements necessary to assure the health and integrity of the CEV throughout its life cycle. For all non-fracture critical parts, the NDE plan shall address how parts that are susceptible to damage such as impact, corrosion, material degradation and wear, etc. will be identified. (The same shall be documented in DRD CEV-T-069, Fracture Control Plan for fracture critical parts.) The NDE plan shall address NDE requirements for inspecting repaired parts. The NDE plan shall address how NDE requirements established through the Material Review process will be implemented. The plan shall address the NDE procedures and physical standards required to perform the O & M NDE inspections.

13.3.11 NDE Reporting: The NDE plan shall describe the NDE nonconformance reporting system, record retention and traceability.

13.3.12 Process Audit: The plan shall address periodic auditing of NDE processes at vendors and subcontractors to verify compliance with the NDE requirements established in the plan.

13.3.13 Personnel Training: The NDE plan shall identify formal training and certification requirements for NDE Inspection.

134 **FORMAI**: Electronic format per Section J-2 2.3.2.1.

135 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

## DATA REQUIREMENTS DESCRIPTION (DRD)

1	<b>PROGRAM:</b> CEV	2	<b>DRD NO.:</b> CEV-T-024
3	<b>DATA TYPE:</b> 2	4	<b>DATE REVISED:</b> 12/21/2005
		5	<b>PAGE:</b> 1

6 TITLE: Corona Design Criteria

7 **DESCRIPTION/USE:**  
To define and document the contractor's design criteria for avoiding damage due to corona, partial discharge or plasma interactions.

8. **DISTRIBUTION:** As determined by the Contracting Officer.

9. **INITIAL SUBMISSION:** Per Data Requirements Matrix

10 **SUBMISSION FREQUENCY:** Per Data Requirements Matrix

11 REMARKS:

The following document(s) may be used as guidance:

- MSFC-STD-531: High Voltage Design Criteria

12 **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.9.1.

### 13. DATA PREPARATION INFORMATION:

13 1 **SCOPE:**

The Corona Design Criteria describes the design methods that the contractor will employ for the control of corona, partial discharge and plasma events.

### 13.2 APPLICABLE DOCUMENTS:

JPR 8080.5, E-6: JSC Design and Procedural Standard E-6, Corona  
Suppression

**13 3 CONTENTS:**

The corona design guide criteria shall include the following:

- a. Scope
- b. Introduction
- c. Applicable environments
- d. Cabling Criteria
  - 1.. Materials
  - 2.. Separation, routing and placement
- e. Connectors
  - 1. Bulkhead and feed through connectors
  - 2. Terminations
  - 3. Standoffs
- f. Electrical/Electronic Components
  - 1. High Voltage Conformal Coating
  - 2. Encapsulation (potting)
  - 3. Insulation Life
- g. Testing

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

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- 13 5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-T-025
3. **DATA TYPE:** 1
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** CEV Electromagnetic Compatibility Control and Verification Document
7. **DESCRIPTION/USE:**  
To define the plans, processes, procedures and test data the CEV System Contractor will use to ensure that the design, construction, and verification of CEV System will result in the delivery of a System which satisfies the specified Electromagnetic Compatibility (EMC) requirements.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
This DRD incorporates Electromagnetic Environmental Effects (EME) information which must be addressed to design, develop, assemble and deliver a CEV which is electromagnetically compatible.  
  
NASA will use the information in this DRD to integrate other Constellation space elements to the CEV.  
  
The following document(s) may be used as guidance:
  - ANSI/ESD S20.20-1999: ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
  - RTCA/DO-160D: Environmental Conditions and Test Procedures for Airborne Equipment (Section 22: Lightning Induced Transient Susceptibility and Section 23: Lightning Direct Effects)
  - SAE-ARP-5412: Aircraft Lightning Environment
  - SAE-ARP-5413: Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning
  - SAE-ARP-5414: Aircraft Lightning Zoning
  - SAE-ARP-5415: Users Manual for Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning
  - SAE-ARP-5416: Aircraft Lightning Test Methods
  - SAE-ARP-5577: Aircraft Lightning Direct Effects Certification
  - SSP 30240: Space Station Grounding Requirements
  - SSP 30242: Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 2.1.9.2.
13. **DATA PREPARATION INFORMATION:**
- 13.1. **SCOPE:**  
The CEV Electromagnetic Compatibility Control and Verification Document includes all of the planning and effort necessary to for the Contractor to control the generation and absorption of electromagnetic energy in every part of the CEV for the complete life cycle of its components. The Contractor is expected to use this DRD as a management document to the meet the overall EMC requirement to be electromagnetically compatible.

13.2 APPLICABLE DOCUMENTS:

MIL-STD-1576: Electro Explosive Subsystem Safety Requirements and Test Methods for Space Systems  
MIL-STD-461E: Requirements for the Control of Electromagnetic Interference (EMI) Characteristics of Subsystems and Equipment  
MIL-STD-464A: Electromagnetic Environmental Effects Requirements for Systems  
ML0303-0014: Electrical Wire Harnesses and Coaxial Cables, Installation Requirements for Electromagnetic Compatibility  
NASA-STD-4003: Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment

13.3 CONTENTS:

The CEV Electromagnetic Compatibility Control and Verification Document shall consist of 7 Sections:

SECTION 1: The Electromagnetic Environmental Effects Control Plan

SCOPE:

The Electromagnetic Environmental Effects Control Plan defines the approach for implementation of an electromagnetic compatibility (EMC) control program. It describes the Contractor control program organization and responsibilities. It also includes interpretation of EMC requirements and a description of additional EMC requirements levied by the Contractor on subsystems and equipment to meet CEV Project EMC requirements. Additionally, this section addresses specific design measures to meet EMC requirements as well as addressing EMC design, test, and analysis requirements.

CONTENTS:

The Electromagnetic Environmental Effects Control Plan shall document the Contractor's approach for implementation of an EMC control program for the CEV System. General and detailed requirements for systems EMC are contained in MIL-STD-464A. The detailed plan shall include:

- (a) Internal organization and responsibility
- (b) System compatibility
- (c) Subsystem compatibility
- (d) Subsystem and equipment requirements
- (e) Electromagnetic interference safety margins for critical equipment
- (f) Interference and susceptibility control
- (g) Degradation criteria
- (h) Subsystem interconnection and routing
- (i) Electrical power and electrical interface, transients, and ripple
- (j) Power frequency leakage current
- (k) Bonding
- (l) Grounding and Isolation
- (m) Static electricity, both ESD and vehicle charging
- (n) Personnel hazards
- (o) Pyrotechnics and bridge wire actuated devices (BWAD's)
- (p) Spacecraft charging controls
- (q) EMC analysis methods and techniques
- (r) EMC verification planning and methodology (verification flow to lower level specifications)

The plan shall include design and test approach that will ensure compatibility within the CEV System as well as with all external interfaces. This includes modification of equipment level requirements to be compatible with special element requirements and the EMC sections of applicable Interface Control Documents (ICD's).

SECTION 2: Electromagnetic Environmental Effects Requirements for Systems

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## SCOPE:

This section establishes the Contractor's requirements for Electromagnetic Environmental Effects Requirements for Systems.

## CONTENTS:

The requirements and considerations of MIL-STD-464A shall be tailored by the contractor for use on the CEV Project to meet the contractual EMC Requirements. The Contractor's tailored version shall include the following sections:

- (a) Contents
- (b) Scope
- (c) Applicable Documents
- (d) Definitions
- (e) General Requirements
- (f) Detailed Requirements
- (g) Notes
- (h) Tables
- (i) Figures

SECTION 3: Cable/Wire Design & Control Requirements Section for Electromagnetic Compatibility (EMC)

## SCOPE:

The Cable/Wire Design and Control Requirements Section for Electromagnetic Compatibility (EMC) shall provide uniform specifications and methodologies for cabling and wiring requirements to ensure the electromagnetic compatibility of subsystems, equipment, and the overall CEV Project. These requirements minimize the effects of electric and magnetic field coupling between the wiring and circuits associated with the wiring.

## CONTENTS:

The Cable/Wire Design and Control Requirements Section for Electromagnetic Compatibility (EMC) section shall provide detailed information regarding cable and wire design characteristics necessary to ensure electromagnetic compatibility. The tailoring of ML0303-0014, 'Electrical Wire Harnesses and Coaxial Cables, Installation Requirements for Electromagnetic Compatibility', SSP 30242 'Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility', and SSP 30240 'Space Station Grounding Requirements' will assist in establishing the Contractor's requirement to meet the overall EMC requirements for CEV. These tailored requirements shall be documented in this section and shall also address as a minimum, the following:

- (a) Circuit Classification
  - 1. Operating Frequency and/or Rise and Fall Times
  - 2. Loop and/or Circuit Impedance
  - 3. Loop and/or Circuit Voltage and Current
  - 4. Loop and/or Circuit Susceptibility
  - 5. Signal and Wire Type
  - 6. An installation specification that complies with either ML0303-0014, or a NASA-accepted alternative that will achieve quality consistent with ML0303-0014, Electrical Wire Harnesses and Coaxial Cables, Installation Requirements for Electromagnetic Compatibility.
- (b) Classification and Wiring Procedure
- (c) Determination of Interface Wiring Requirements
- (d) Signal and Wire Types
- (e) Shield Termination
- (f) Implementation of Signal/Circuit Type Coding
- (g) Implementation of Harness Installation
  - 1. Physical Separation Requirements
  - 2. Shield Termination



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- 3. Breakouts
- 4. Pyrotechnic Devices.
- (h) Circuit Grounding

## SECTION 4: Electromagnetic Environmental Effects Design Analysis Reports

## SCOPE:

This section of the CEV Electromagnetic Compatibility Control and Verification Document defines the content that will be delivered in the Electromagnetic Environmental Effects Design Analysis Reports that will be delivered in accordance with other DRDs for the delivery of CEV evaluation, verification and certification documents. The Electromagnetic Environmental Effects (E3) Design Analysis Reports describes the design, analyses, tests and results of efforts to ensure individual equipment meets the E3 requirements and the entire system is compatible.

## CONTENTS:

The Electromagnetic Environmental Effects (E3) Design Analysis Reports shall describe the approach taken to ensure E3 requirements are met in accordance with Electromagnetic Environmental Effects (E3) Control Plan and the results of that effort. The reports are delivered in accordance with requirements to provide evaluation, verification and certification data for developed and integrated hardware. Reports shall include the following informational items (where applicable) for hardware:

- (a) Electrical bonding
- (b) Circuit grounding and isolation
- (c) Cable design and routing
- (d) Connector separation and shield termination
- (e) Frequency management
- (f) Emission and susceptibility control
- (g) Critical circuit identification
- (h) Lightning protection
- (i) Electrostatic discharge protection
- (j) Analyses results
- (k) Test results

## SECTION 5: Requirements for the control of Electromagnetic Interference (EMI) characteristics of subsystems and equipment intended for use by the CEV Project

## SCOPE:

This section establishes interface and associated verification requirements for the control of electromagnetic interference (emissions and susceptibility) characteristics of hardware procured for use by the CEV Project. Such hardware may be used independently or as an integral part of other hardware. This section is directly applicable to items such as electronic enclosures and electromechanical systems and electrical interconnections composed of discrete wiring harness between enclosures.

## CONTENTS:

MIL-STD-461E shall be tailored to describe the interface and associated verification requirements for the control of electromagnetic interference (emissions and susceptibility) characteristics of electrical, electronic, and electromechanical equipment and subsystems designed or procured for use by the CEV Project. As a minimum the following sections of MIL-STD-461E shall be addressed:

- (a) Scope
- (b) Applicable Documents
- (c) Definitions
- (d) General Requirements
- (e) Detailed Requirements

## SECTION 6: Electrostatic Discharge (ESD) Control Plan

### SCOPE:

The Electrostatic Discharge Control Plan defines the tasks, activities and procedures necessary to protect CEV Project ESD sensitive items at or above the ESD sensitivity levels defined for the CEV Project. The Plan outlines strategies for meeting administrative and technical requirements, and shall include information about organizational responsibilities, methods for measuring ESD control effectiveness, and the approach to be used for utilization of CEV Project data and documentation. The Plan shall address training, compliance verification, facility grounding & bonding, personnel grounding, protected areas, packaging, marking, and handling.

### CONTENTS:

The Electrostatic Discharge Control Plan establishes methods and procedures to be implemented for system, subsystem, and component protection from the deleterious effects of ESD, and shall address the following areas as a minimum:

- (a) Administrative Requirements
  - 1. ESD Control Program Plan
    - (a) Scope
    - (b) Tasks, Activities and Procedures Necessary for Protection of ESD Sensitive Items
    - (c) Organizational Responsibilities
    - (d) Methods Used to Determine ESD Sensitivity assessment
  - 2. Employee Training
    - (a) Initial Training
    - (b) Recurrent Training
    - (c) Procedures for Recording Training
  - 3. Compliance Verification Plan
    - (a) Identifies Requirements to be verified
    - (b) Frequency of Verification
- (b) Technical Requirements
  - 1. Grounding/Bonding Systems
  - 2. Personnel Grounding
  - 3. Protected Areas
  - 4. Packaging
  - 5. Marking
  - 6. Equipment
  - 7. Handling Procedures
  - 8. Implications for other system elements

## SECTION 7: CEV Project Lightning Protection

### SCOPE:

This Section specifies the CEV lightning protection evaluation and design requirements, and defines the analysis and testing used to demonstrate CEV systems meet their performance requirements while operating in the defined external lightning environment.

### CONTENTS:

A) The CEV Lightning Protection Plan (LPP): The LPP describes the considerations that must be addressed by the Contractor in carrying out overall design, planning, demonstration, and management of lightning protection for the CEV spacecraft, modules, subsystems, and components. The LPP provides means for NASA evaluation and judgment of acceptability of the Contractor's proposed lightning protection program and shall contain the following elements:

- (a) Management control
- (b) Lightning zone identification

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- (c) Vehicle lightning environment
- (d) Lightning criticality
- (e) Hazards assessment
- (f) Direct effects protection
- (g) Indirect effects protection
- (h) Cumulative effects
- (i) Electrical bonding and corrosion control
- (j) Design analysis/development testing
- (k) Verification criteria
  - 1. Applicable documents
  - 2. Description of test articles
  - 3. Pass/fail criteria
  - 4. Test hardware definition
  - 5. Pertinent test/analysis details
  - 6. Set up details
  - 7. Test schedule
- (l) Life cycle aspects
- (m) Configuration/documentation control
- (n) Protection of facilities and ground support equipment
- (o) Lightning protection survey

B) The CEV Lightning Protection Verification Plan (LPVP): The LPVP shall include the test/analyses data and methods to be used as well as the pass/fail definitions for each subsystem/component to verify lightning protection designs for those designated as Catastrophic, Hazardous/Severe-Major, or Major. The plan shall contain the following:

- (a) Applicable documents.
- (b) Description of test articles.
- (c) Pass/fail criteria.
- (d) Test hardware definition.
- (e) Pertinent test/analysis details.
- (f) Set-up details.
- (g) Test schedule.
- (h) Final Lightning protection survey

C) Lightning Protection Verification Report (LPVR): The CEV Electromagnetic Compatibility Control and Verification Document shall define the data content required in the LPVR that is delivered in accordance with requirements to provide verification and certification data for developed and integrated hardware. The LPVR presents the results of analyses, tests, and other data needed to verify the adequacy of lightning protection designs for all systems, subsystems, and/or components whose failure is designated as Catastrophic, Hazardous/Severe-Major, or Major. The LPVR provides the means for NASA evaluation and judgment of the acceptability of the contractor's lightning protection designs and hardware/software. The report shall contain the following:

- (a) Description and photographs of test set-up, including associated load impedances.
- (b) Date, personnel performing test, and location of test.
- (c) Test current amplitude and waveforms.
- (d) Conducted and induced voltages and currents measured.
- (e) Measurement records of the instrumentation noise level.
- (f) Test results.
- (g) Statement of qualification.

13.4 **FORMAI:** Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE:** Maintained through formal Program change process after initial baselining.



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12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 3.2.

13. **DATA PREPARATION INFORMATION:**

13.1 **SCOPE:**

This document establishes the CEV System ground processing safety policy, criteria, and requirements for CEV Contractor-provided portable GSE. It provides the detailed safety requirements for ground operations and CEV/GSE design. This document will not address facility GSE, or flight safety.

Associated applicable Occupational Medicine and Environmental Health requirements shall be included in this document.

13.2 **APPLICABLE DOCUMENTS:**

CXP-02012: Methodology For Conduct of Project Constellation Hazard Analyses

NASA-STD-8719.9: NASA Standard for Lifting Devices and Equipment

OSHA Standards 29 CFR: Supplementary Standards 1960.18

13.3 **CONTENTS:**

The document shall contain the Contractor's procedures for:

- 1) Phase Safety Reviews
- 2) Safety Documentation
- 3) Safety Requirements
- 4) Mishap Investigation and Report

1) Phase Safety Reviews

The CEV Contractor shall document its plan for support of the phase safety review process per Constellation document CXP-02012, Methodology For Conduct of Project Constellation Hazard Analyses. This procedure provides for an early safety interface to be established between the CEV Contractor and the Processing/Launch site.

The CEV Contractor shall prepare a safety data package including those data elements required by CXP-02012, Methodology For Conduct of Project Constellation Hazard Analyses, for the ground safety review panel. These reviews provide for the delivery of safety documentation required by the Processing/Launch site prior to delivery of the CEV Spacecraft and GSE to that site. This documentation is further discussed in KHB 1700.7, Paragraph 3.

2) Safety Documentation

a) General:

This document shall include the Contractor's procedure for identifying, documenting and submitting the documentation required by the Constellation Program for the phase safety review process. The documentation submitted shall be consistent with the Phase Level under review.

b) Phase Safety Review Documentation:

The documentation shall include verification to the PSSO/LSSO that hazards that are not eliminated by design exist for valid technical reasons and are not for operational convenience or cost savings. These hazards can cause operational restrictions that could limit personnel numbers, require a specific sequence of operations, or limit operations to specific facilities. As a result of this information presented at the ground safety review, the PSSO/LSSO will communicate, in writing, to the CEV Contractor, the rationale for any restrictions imposed on the CEV Spacecraft or CEV GSE design as early as possible. The PSSO/LSSO will also assist the CEV Project and Contractor in determining the course of action which can best serve operational efficiency.

This document shall include:

1. Block diagrams, schematics, and descriptions of safety critical subsystems. This includes tables of design and operating parameters for such items such as lifting equipment, pressure systems, ordnance, and batteries.
2. Launch site processing plan including timelines for handling, storage, assembly, servicing, and checkout operations.
3. List of Technical Operating Procedures (TOP's), a synopsis of each procedure, and their preliminary classifications, i.e., hazardous or non hazardous.
4. Documentation certifying compliance with ionizing radiation control requirements.
5. Hazard reports addressing both design and operations.
6. Failure/accident summary reports.
7. Copies of all noncompliance reports.
8. Ordinance storage and handling data requirements.
9. A list of all hazardous materials and physical agents. Material Safety Data sheets (MSDS's) shall be provided to the PSSO/LSSO for all material and agents brought by the CEV contractor.
10. A list of all plastic films, quantity, and location of use.
11. List of the CEV Spacecraft T-0 umbilical functions, if any.
12. Identification of Critical software commands and verification of how they are managed. These critical software commands include commands which, if executed or executed out of sequence, would create a hazardous condition or would remove a safety inhibit.
13. Potential hazards resulting from the human interface shall be addressed by the CEV contractor during the phase review process.
14. Mechanical or electromechanical devices that must be failure tolerant shall be identified in the operational hazards analysis with the requirement for caution and warning notations incorporated in the TOP's

c) Processing site & Launch Site Documentation:

The CEV Contractor shall demonstrate (via the Processing site and Launch Site documentation), in the form of detailed documentation, that it (the CEV contractor) is cognizant of and has the means to implement the safety and health policies and requirements of the Processing/Launch sites. The Contractor shall provide Facility Safety Plans and Emergency Procedure Documents (EPD's) for all CEV facility/area users. These Facility Safety Plans and Emergency Procedure Documents (EPD's) developed for the Processing/Launch sites, contain specific requirements for hazardous processing facilities/areas and will be mandatory for all facility/area users.

d) CEV Contractor Processing/Launch Site Safety Plan:

The CEV Contractor shall provide a Processing/Launch Site Safety Plan that demonstrates the means by which the Contractor manages and interfaces safety within its organization and how it applies the Processing/Launch site safety requirements. The specifics of the plan contents shall be identified by the CEV Contractor early in the phase safety review process. All plans shall be tailored to the complexity of the CEV Spacecraft and GSE and be provided to the PSSO/LSSO for review and approval at least 30 days prior to first hardware delivery (including GSE) to the processing site/launch site.

e) Technical Operation Procedures (TOP's):

The CEV Contractor shall develop detailed step-by-step instructions for the conduct of all CEV Spacecraft and GSE ground operations in Technical Operation Procedures (TOP's). All TOP's designated hazardous by the PSSO/LSSO or by the CEV Project shall be presented to the PSSO/LSSO for approval, and when approved shall be published and 'on the shelf' 10 days prior to use (7 days prior to use for revisions). TOP's which are

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performed on Cape Canaveral Air Force Station, shall be submitted 30 days prior to use to the 45th Space Wing

The Contractor shall notify the LSSR for all hazardous or LSSO-designated procedures at least 24 hours prior to their performance. The LSSR will monitor all or selected sections of these procedures.

The CEV Contractor shall submit draft or preliminary procedures to the PSSO/LSSO. Where procedures are used to control hazards identified in the hazard reports, a listing of those procedures and the applicable step numbers which control the hazard shall be identified in the Phase 3 safety data package.

f) CEV Safety Noncompliance Reports:

[The CEV Contractor must comply with all the requirements of KHB 1700.7, Ground Safety Handbook or obtain an approved waiver/deviation for each case of inability to comply with a specific safety requirement. This document shall include all waiver/deviation requests in accordance with the requirements below (i, ii)]

The PSSO/LSSO shall coordinate the waiver/deviation requests and provide rationale for approval or disapproval to the appropriate authority. Processing/Launch site waivers/deviations shall be granted only by authority of the KSC Center Director or 45th SW Commander and are not transferable. CEV Contractors shall be formally notified of the disposition of the waiver/deviation request.

i) Waivers - Each waiver request shall be limited to a specific subsystem or component in a specific application. The CEV Contractor is responsible for correcting the waived condition prior to the reflight of the CEV Spacecraft on another Exploration mission or the flight of subsequent CEV Spacecraft of the same series or 'block'. If the waived condition is not corrected, a new waiver request is required. The new request must contain additional rationale, justifying continued noncompliance, and a copy of the original waiver must be attached. Waiver requests should be submitted as soon as the need is identified. Prior to submittal, all waiver requests should be coordinated with the appropriate governmental sponsor and submitted to the PSSO/LSSO.

ii) Deviations - When a deviation is granted, the noncompliance condition may be approved for more than one mission. Deviations shall be applicable where the associated hazard to the Launch Vehicle is not affected by manifesting with other Exploration CEV Spacecraft or GSE, location of the CEV Spacecraft in the Launch Vehicle, or mission unique environmental conditions. Noncompliance reports to be considered for a deviation will be those where the design, procedure, configuration, etc., do not comply with the safety requirement in the exact manner specified, but the intent of the requirement has been satisfied and a comparable or higher degree of safety is achieved.

g) Documentation Changes:

This document shall include Contractor provided changes or modifications which affect any approved phase safety review or Processing/Launch site documentation, to the PSSO/LSSO for review and re-approval.

3) Safety Requirements:

The CEV Contractor shall comply with the following policies, practices, and regulations.

a) Operational Considerations:

i) Failure Tolerance - The interaction of the CEV Spacecraft, GSE, Processing/Launch site facilities, and operator monitoring/intervention must tolerate the required minimum number of credible failures and operator errors as determined by the hazard level analyses. This applies

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when failure to perform a function or the inadvertent performance of a function results in a hazardous event. The requirements contained in KHB 1700.7, Section 4, Safety Requirements, are intended to provide the proper failure tolerance for GSE when used alone or in conjunction with a CEV Spacecraft and/or facility. Verification of compliance with the technical requirements of this document will normally demonstrate the intent of this paragraph. When the technical requirements do not provide for failure tolerance, the adequacy of the controls shall be determined during the safety review process.

ii) Personnel Policies - This document shall provide a description of their training and certification program to the PSSO/LSSO, as part of the CEV organization Processing/Launch Site Safety Plan. This training and certification program shall specify the personnel training required and the certification procedures employed to establish acceptable skill levels for all personnel involved in the ground processing of CEV Spacecraft and GSE. Ground processing shall be performed only by persons certified in the discipline required for that process.

iii) Hazardous Operations

a. A ground processing activity is classified as hazardous based, but not limited, on the following considerations:

- (1) Energy is involved and loss of control could result in injury to personnel or damage to equipment.
- (2) A significant change from ambient condition will occur; e.g., increase or decrease of oxygen content, pressure, or temperature.

(3) Presence of hazardous materials or physical agents which presents potential exposure to personnel.

b. The CEV Contractor shall generate TOP's for any activity, either by itself or in combination with another, which can result in injury to personnel or damage to property involving, but not limited to, the following:

- (1) Work Area/Environment.
- (2) Ordnance.
- (3) Propellants.
- (4) Cryogenics.
- (5) Lifting/Handling.
- (6) Radiation.
- (7) Toxics/Combustibles/Corrosives
- (8) Pressure.
- (9) Electrical.

c. The CEV Contractor shall notify the PSSR/LSSR at least 24 hours in advance of all hazardous or PSSO/LSSO designated procedures. The PSSR/LSSR will monitor all or selected sections of these procedures.

d. The CEV Contractor shall not perform concurrent hazardous operations within the same hazard control area (including those hazardous control areas where the concurrent operation may not be a CEV Spacecraft operation).

e. The CEV Contractor shall obtain PSSR/LSSR or PSSO/LSSO approval prior to conducting concurrent operations within a hazard control area.

iv) Safety Inspection - This document shall include a list of all joint systematic safety inspections of the facility, working environment, related GSE, and any work in progress which could cause accidental injury to personnel or damage to hardware. The CEV Contractor shall give primary emphasis to include CEV Spacecraft, GSE, critical processing equipment, facility maintenance status and associated equipment locations, and facility ingress/egress provisions and routing. Discrepancies identified from any of the inspections shall be corrected by the appropriate organization prior to conducting hazardous operations or bringing hazardous materials into the area.

v) Safety Equipment - This document shall identify all processing activities that will require personnel protection equipment (PPE). The



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CEV Contractor shall submit a list of personnel protective equipment to the PSSSO/LSSO and Biomedical Office for approval.

This document shall include a list of personnel protection provided when engineering controls alone are not adequate to provide sufficient employee protection. CEV Spacecraft and GSE processing activities which are considered normal to general industry shall be in compliance with the requirements of accepted industrial safety practices. CEV Spacecraft and GSE processing operations which require PPE shall be identified in the appropriate sections of this document. The CEV Project, with CEV Contractor support is required to review with the PSSO/LSSO and Biomedical Office those operations not specifically identified which might require PPE. All PPE shall be approved by the PSSO/LSSO and Biomedical Office.

vi) Tools

Temporary Restraints - This document shall include a list of temporary restraints, such as tethers, for individual tools to prevent misplacement or loss in critical areas when working above personnel or sensitive equipment and provide an effective tool control program.

Control of Tools - This document shall identify the CEV Contractor means to implement the requirement that all tools and related equipment used in the proximity of flight articles shall be controlled to minimize the potential for foreign object damage.

vii) Photography

The CEV Contractor shall follow the PSSO/LSSO requirements for the use of photographic lighting equipment. This requires that the use of photographic lighting equipment (e.g., flashbulbs, strobe lights, and photofloods) be restricted within 100 feet of the Launch Vehicle/CEV Spacecraft whenever they are loaded with any propellant, within 100 feet of a propellant storage tank, and within 10 feet of exposed solid propellants. Photo equipment used above a CEV Spacecraft must be tethered and the light sources shielded to prevent debris from falling onto the CEV Spacecraft. The CEV Contractor shall obtain PSSO/LSSO approval to use photographic equipment in these and other hazardous atmosphere locations.

b) Personnel Safety:

This document shall include the requirements and verification process that the CEV Contractor shall use to ensure a safe and healthful working environment through good design, effective training, and appropriate PPE.

i) Human Factors - The CEV Contractor shall consider human factors in the design of GSE and the CEV Spacecraft.

The CEV Contractor shall address potential hazards resulting from the human interface during the Phase Safety Review Process. To minimize the effects of these hazards, the CEV Contractor shall apply the following criteria in the design and development of the CEV Spacecraft, GSE, and ground operations: Human Error, Noise, Hazardous Materials, Physical, Temperature and Radiation.

c) CEVs and GSE

i) Biomedical Subsystems - This document shall provide complete handling procedures for all hazardous biomedical subsystems. Hazardous biomedical subsystems consist of medical experiment equipment designed to obtain data on human adaptation and performance in the space environment. They also consist of scientific equipment designed to obtain experimental data on the effects of space environments on microorganisms, plant, and animal life.

ii) Electrical - This document shall specify CEV Contractor compliance for all CEV Spacecraft and CEV GSE electrical equipment with the requirements in KHB 1700.7, Section 4.3.2, Electrical. These requirements preclude hazardous conditions associated with grounding, bonding, and shielding, electrical maintenance operations, electrical control of hazardous functions, energized electrical equipment and battery charging operations.

iii) Pressure/Vacuum Systems - This document shall specify CEV

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Contractor compliance for all CEV Spacecraft and CEV GSE pressure/vacuum equipment with the requirements in KHB 1700.7, Section 4.3.3, Pressure/Vacuum. Pressurized systems contain fluids or gases above atmospheric pressure. Vacuum systems contain fluids or vacuum below atmospheric pressure. Pressure system elements include tanks, accumulators, lines (e.g., piping, tubes and hoses), fittings, gauges, filters, valves, regulators, and other components. Pressure and vacuum systems requirements apply for both flight and ground systems, including GSE containing pressure systems, vacuum systems and hydraulic systems.

iv) Pressure System Operations - The CEV Contractor shall obtain PSSO/LSSO approval prior to performing certain flight and ground support system pressurization operations. Unless approved by the PSSO/LSSO these operations shall be performed remotely (e.g., locate control station behind a blast shield). Personnel will be allowed in the immediate proximity of systems only when pressure does not exceed Maximum Operating Pressure (MOP), and system integrity is maintained on pressure fittings, lines, tanks and gauges.

v) Ordnance - This document shall specify CEV Contractor compliance with the applicable Processing/Launch site requirements for ordnance. This includes ordnance classification, general ordnance requirements, safe and arm (S&A) devices, ordnance operation, ordnance marking and ordnance test equipment.

vi) Radiation - This document shall specify CEV Contractor compliance with the applicable Processing/Launch site requirements for radiation. Sources of ionizing and non-ionizing radiation shall be adequately controlled during all phases of ground, launch, and post-launch operations to assure the protection of personnel, facilities, and equipment, and the compliance with applicable federal, state, and NASA/DOD regulations and requirements.

vii) Mechanical, Electromechanical Devices - This document shall specify CEV Contractor compliance with the applicable Processing/Launch site requirements for mechanical, electromechanical devices. Mechanical or electromechanical devices used for such purposes as structure deployment or actuating release mechanisms shall be evaluated to establish whether in the event of inadvertent activation damage to equipment or injury to personnel could occur. If it is determined inadvertent activation is either critical or catastrophic, then the device shall be failure tolerant in accordance with KHB 1700.7, Paragraph 4.1.1, Failure Tolerance. These devices shall be identified in the operational hazards analysis with the requirement for caution and warning notations incorporated in the TOP's (See KHB 1700.7, Section 3.3.2, TOP's).

viii) Propellants - This document shall specify CEV Contractor compliance with the applicable Processing/Launch site requirements for propellants.

ix) Cryogenics - This document shall specify how all cryogenic systems comply with the requirements of KHB 1700.7, Paragraph 4.3.7, Propellants including cryogenic systems requirements and cryogenic systems operations.

x) GSE Materials - This document shall include a list of materials for each piece of GSE which interfaces with hazardous fluids. Hazardous fluids include, but are not limited to, gaseous oxygen, liquid oxygen, gaseous hydrogen, liquid hydrogen, hydrazine, nitrogen tetroxide, mono-methyl-hydrazine, ammonia, and potassium hydroxide. This list will be of sufficient detail to permit an evaluation of the compatibility of the GSE design with the environment in which it is to be used.

xi) Industrial Hygiene - This document shall specify how hazardous materials and physical agents will be controlled during all phases of processing/launch/landing site operations to protect personnel by preventing exposures in excess of applicable limits and to be in compliance with applicable federal and state regulations and requirements. covered by 3)a)i).

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xii) Oxygen - This document shall identify specific oxygen safety/compatibility requirements to be incorporated in design. The Contractor shall support the Project in presenting these specific requirements to the PSSO/LSSO prior to the commencement of the design

d) Environment

i) Meteorological Requirements - This document shall include the meteorological conditions/limits to be followed for scheduling and conducting transfer, handling, and use of toxic propellants.

ii) Hazardous Atmosphere - This document shall include the hazards associated with hazardous atmospheres including oxygen deficient atmospheres and those operations where they apply per KHB 1700.7, Section 4.4.2.1 General - Hazardous atmospheres

iii) Confined Space Entry - This document shall include those operations that involve confined space entries and the hazards involved as well as the controls and mitigations.

iv) Humidity - This document shall include all operations involving solid or liquid propellants or Category A Electro explosive Devices (EED's) to show how they it will be verified to not conduct at humidity levels below 30%. The Contractor shall support the CEV Project in seeking exceptions to this requirement to the PSSO/LSSO on a case-by-case basis.

v) Toxic Materials - This document shall include the operational controls involving all toxic materials and show compliance with the PSSO/LSSO and Biomedical Office established criteria.

e) Handling and Transports

This document shall show how the Contractor is in compliance with the Code of Federal Regulations, 29 CFR, 'Occupational Safety and Health Administration, Department of Labor,' Part 1910, and the NASA-STD-8719.9: NASA Standard for Lifting Devices and Equipment. The special nature of processing/launch site safety mandates rigorous considerations in both design and process parameters.

i) Hoisting and Handling - This document shall include how all CEV Spacecraft lifting equipment and its usage meet the requirements of 29 CFR, Part 1910; and the NASA-STD-8719.9: NASA Standard for Lifting Devices and Equipment (via Constellation Safety Requirements Document) including requirements for slings, hydra sets, chain falls, load cells and stands.

ii) Transporters

a. This document shall include the required checks and inspections, prior to use, for transporters to ensure -

- (1) Proper tire inflation.
- (2) An operable braking system.
- (3) Tow bar and safety chains are properly fastened.
- (4) CEV Spacecraft securing devices are properly tightened.
- (5) Availability of wheel chocks.
- (6) Availability of fire extinguisher(s).
- (7) Proper steering mechanism operation.

#### 4) Mishap Investigation and Reporting

This document shall include the procedure for investigation of mishaps and anomalies involving CEV Spacecraft and associated GSE occurring after arrival at NASA facilities and the reporting to the Project office, the KSC Safety Office, and the PSSO/LSSO. This procedure shall include the Contractor support for government-directed mishap investigation, including, but not limited to, providing records, data, administration and technical support, and other services as may be requested by the NASA investigating board/official.

a) USAF Mishap Investigation Control

This document shall include the procedures for reporting and investigation of mishaps involving DoD personnel, or occurring on Air Force property.

- 13.4 **FORMAT**: Format shall follow documented processes and procedures in KHB 1700.7 Ground Safety Handbook.
- 13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue

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## DATA REQUIREMENTS DESCRIPTION (DRD)

- |   |                     |   |                                 |
|---|---------------------|---|---------------------------------|
| 1 | <b>PROGRAM:</b> CEV | 2 | <b>DRD NO.:</b> CEV-S-006       |
| 3 | <b>DATA TYPE:</b> 1 | 4 | <b>DATE REVISED:</b> 12/20/2005 |
|   |                     | 5 | <b>PAGE:</b> 1                  |
6. **TITLE:** Hazardous, Key Operations List
7. **DESCRIPTION/USE:**  
This list will aid and inform NASA of all planned hazardous operations (during the contract period including design, development, testing, and operations of the CEV System), all major or key operations and allow reasonable precautions to be undertaken for these tasks and ensure compliance with NFS 1852.223-70 -NASA FAR Supplement, Safety and Health, paragraph j. NASA and the Contractor will jointly decide which of the key operations are to be considered hazardous, with NASA having the final authority. This will allow all prudent precautions to be undertaken prior to the start of hazardous operations, lowering the overall project risk.
8. **DISTRIBUTION:** As determined by the Contracting Officer
9. **INITIAL SUBMISSION:** Draft due at System Definition Review
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix  
Draft due at System Definition Review.  
Update due at Preliminary Design Review.  
Final due at Critical Design Review
11. **REMARKS:**  
Yearly updates as operations are defined.  
Prior to hazardous operations commence, the Contractor will submit the list for NASA review and concurrence.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 3.2.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Hazardous and Key Operations List shall include a list and description of all hazardous operations to be performed, and a list of other major or key operations required or planned in the performance of the contract, even though not deemed hazardous by the Contractor. This list shall be developed in collaboration with NASA to jointly decide which operations are to be considered hazardous, with NASA as the final authority.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The Hazardous and Key Operations List shall list and describe all hazardous operations planned to be performed for the contract (during the contract period including design, development, testing, and operations of the CEV System), along with an explanation of each operation, describing in detail the hazards that will be need to be mitigated during these operations, as well as the mitigation plan. The list will also detail when the operations are planned, where they are to take place, who will be involved with the operations, the facilities and hardware exposed to

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the hazards as well as the personnel.

The list shall describe all major or key operations even though the Contractor may not deem them hazardous, for NASA review, and joint discussion with the contractor. This list shall contain a detailed description of the operation, where they are to be performed, who will be involved with the operation, the facilities and hardware involved as well as the personnel.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2 1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-S-007
3. **DATA TYPE:** 1
4. **DATE REVISED:** 12/20/2005
5. **PAGE:** 1
6. **TIITLE:** Orbital Debris Assessment
7. **DESCRIPTION/USE:**

The debris assessment must address the potential for orbital debris generation that results from normal operations and malfunction conditions, and on-orbit collisions. The assessment must also address provisions for postmission disposal. Malfunction conditions refer to those credible failure scenarios or conditions that can result in the direct generation of orbital debris or that can disable the spacecraft to preclude postmission disposal.
8. **DISTRIBUTION:** As determined by the Contracting Officer
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**

The initial report shall be submitted at Preliminary Design Review with a final assessment 45 days prior to Critical Design Review. The Preliminary Design Review debris assessment should identify debris generation issues and, where possible, assess those issues. The Critical Design Review assessment should identify, assess, and resolve all debris issues in detail.

CEV should be designed to limit orbital debris in accordance with NSS-1740.14, Guidelines and Assessment Procedures for Limiting Orbital Debris, and dispose of any orbital debris per Sections 6 and 7 of this document. The required format for the assessment reports has been tailored from Section 8 of this document and is included in Section 13.3 of this DRD.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 3.2
13. **DATA PREPARATION INFORMATION:**
  - 13.1 **SCOPE:**

The debris assessment covers two broad areas: the potential for generating debris during normal operations or malfunction conditions, and the potential for generating debris by collision with space debris (natural or human-generated) or orbiting space systems.

These two broad areas are broken down into five issues to be addressed in the assessment:

    - Debris released during normal operations
    - Debris generated by explosions and intentional breakups
    - Debris generated by on-orbit collisions during mission operations
    - Safe disposal of space systems after mission completion
    - Structural components impacting the Earth following post-mission disposal by atmospheric reentry

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The assessment will be organized around these issues with specific guidelines associated with each. The objective is to assess whether all applicable guidelines have been met.

13.2 **APPLICABLE DOCUMENTS:**

NSS-1704.14: Guidelines and Assessment Procedures for Limiting Orbital Debris

13.3 **CONTENTS:**

The Contractor shall provide the following data in the described format for the PDR debris assessment report:

## Section 1: Brief Background on Project

To include

- Mission Description
- Project objectives
- Project schedule

## Section 2: Description of Design and Operations Factors

## 2.1 Hardware

To include (as available)

- Physical description of main structure
- Description of surfaces/materials exposed to space
- Description of spacecraft components most sensitive to debris impact
- Description and location of pressurized volumes
- Description of on-board propellants
- Description and location of fuel storage and transport systems
- Description of range safety systems
- Description of systems containing stored kinetic energy

## 2.2 Mission Parameters

To include

- Number of spacecraft
- Launch date and time
- Mission orbit (apogee/perigee altitude, inclination)
- Flight attitude

## Section 3: Assessment of Debris Released During Normal Operations

## 3.1 Debris Released During Staging, Payload Separation, or Payload Deployment

To include

- Preliminary description of debris released and associated orbits
- Preliminary estimate of area-time and object-time products

## 3.2 Debris Released During Mission Operations

To include

- Preliminary description of debris released and associated orbits
- Preliminary estimate of area-time and object-time products

## Section 4: Assessment of Orbital Debris Generated by Explosions and Intentional Breakups

## 4.1 Explosions from On-Board Stored Energy

To include

- General description of systems or components containing stored energy
- General plan for depleting stored energy sources after completion of mission

## 4.2 Intentional Breakups

To include

- General description of object being fragmented
- Description of energy source



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- Description of orbit in which breakup will occur, and location and altitude of breakup
- Description of breakup model
- Preliminary estimate of area-time and object-time product of breakup fragments
- Preliminary plan for assessing risk to other operating spacecraft from the debris cloud formed immediately after the test

## Section 5: Assessment of Debris Generated by On-Orbit Collisions

## 5.1 Assessment of Collisions with Large Objects During Mission Operations To include

- Estimate of probability of impact with large objects, based on planned mission

## 5.2 Assessment of Collisions with Small Debris During Mission Operations To include

- Identification of systems or components most vulnerable to debris impact
- Preliminary assessment of shielding requirements, design considerations

## Section 6: Description of Post mission Disposal Procedures and Systems To include

- Planned option for post mission disposal
- Description of disposal procedures and systems
- Identification of obstacles to successful post mission disposal

## Section 7: Assessment of Survival of Debris from the Post mission Disposal

## Atmospheric Reentry Option

## To include

- Initial assessment of structures which will survive uncontrolled reentry
- Conservative estimate of total debris casualty area for debris surviving uncontrolled reentry
- Preliminary plan for atmospheric reentry if it appears that the guideline of 8 m<sup>2</sup> will be violated

The contractor shall provide the following data in the described format for the CDR debris assessment report:

## Section 1: Brief Background on Project

## To include

- Mission description
- Program/project objectives
- Program/project schedule

## Section 2: Description of Design and Operations Factors

## 2.1 Hardware

## To include

- Physical description of main structure
- Description of surfaces/materials exposed to space
- Description of spacecraft components most sensitive to debris impact
- Description and location of pressurized volumes
- Description of on-board propellants
- Description and location of fuel storage and transport systems
- Description of range safety systems
- Description and location of systems containing stored kinetic energy

## 2.2 Mission Parameters

## To include

## Crew Exploration Vehicle – (CEV)

- Number of spacecraft
- Launch date and time
- Mission orbit (apogee/perigee altitude, inclination)
- Flight attitude

## Section 3: Assessment of Debris Generated During Normal Operations

## 3.1 Debris Released During Staging, Payload Separation, or Payload Deployment

## To include

- Description of debris to be released, including size, mass, cross-sectional area, initial orbit, orbit lifetime
- Calculated area-time for debris larger than 1 mm (m2-yr)
- Calculated object-time for debris larger than 1 mm (yr)
- Calculated time for removal of debris from GEO altitude to at least 300 km below GEO altitude
- Source for analysis if not this standard or the debris assessment software

## 3.2 Debris Released During Mission Operations

## To include

- Description of debris to be released, including release time, size, mass, cross-sectional area, initial orbit, orbit lifetime
- Maximum total cross-sectional area of debris in orbit at any given time (m2)
- Calculated area-time for debris larger than 1 mm (m2-yr)
- Calculated object-time for debris larger than 1 mm (yr)
- Calculated time for removal of debris from GEO altitude to at least 300 km below GEO altitude
- Source for analysis if not this standard or the debris assessment software

## Section 4: Assessment of Debris Generated by Explosions and Intentional Breakups

## 4.1 Explosions From On-Board Stored Energy

## To include

- Description of failure modes leading to explosion
- Description of systems involved in explosive failure, including the following:
  - Fluid: mass, chemical composition, pressure, energy density
  - Structure: size, materials, thickness, location relative to direction of motion, shielding from environment, most probable failure modes
- Estimated probability of explosion if quantified in assessment
- Detailed plan for safing structure after completion of mission

## 4.2 Intentional Breakups

## To include

- Description of energy source, total energy content
- Altitude and location of breakup
- Description of model for breakup
- Description of mission including state vector at explosion
- Calculated area-time for debris larger than 1 mm (m2-yr)
- Plan for assessing risk to operating spacecraft from the debris cloud formed immediately after the test
- Documentation of dry run for risk analysis using predicted event time and current USSPACECOMMAND catalog elements

## Section 5: Assessment of Debris Generated by On-Orbit Collisions

## 5.1 Assessment of Collisions with Large Objects During Mission Operations

## To include

- Estimated probability of collision with intact space systems or large debris
- Plan for limiting probability, if applicable

## 5.2 Assessment of Collisions with Small Debris During Mission Operations

## Crew Exploration Vehicle - (CEV)

To include

- Description of primary mission failure modes from meteoroid or orbital debris impact
- Description of design measures taken to protect against impacts with meteoroids or orbital debris, if applicable

Section 6: Assessment of Post mission Disposal Procedures and Systems

6.1 Description of Post mission Disposal Option and Disposal System

To include

- Statement of disposal option exercised
- Disposal plan and description of supporting systems (final orbit parameters, delta v requirement, disposal system design, etc.)
- Source for analysis or the debris assessment software

6.2 Assessment of Potential Failures that Prevent Successful Post mission Disposal

To include

- Description of primary failure modes leading to loss of control during mission operations—from design or from impact with small debris
- Assessment of failure of the post mission disposal system to work properly

Section 7: Assessment of Survival of Debris from the Post mission

Disposal Atmospheric

Reentry Option

To include

- Verification that surviving debris is within guidelines
- Source for analysis or the debris assessment software

- 134 **FORMAT**: Per 13.2 for both reports as applicable.  
Electronic format per Section J-2 2.3 2.1

- 135 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

1 PROGRAM: CEV  
2 DRD NO.: CEV-S-008  
3 DATA TYPE: 1  
4 DATE REVISED: 12/20/2005  
5 PAGE: 1

6 TITLE: Safety and Health Plan

7 DESCRIPTION/USE:  
NASA policy requires that contractors submit safety and health plans as part of the proposal. The plan will demonstrate the seriousness of the offeror's intent to excel in its implementation of its safety and health program as a early indicator of its safety culture. The requirements captured below emulate the elements of OSHA's Voluntary Protection Program and as such represent all the elements of a successful safety and health program. Many NASA centers have been certified as OSHA VPP sites, indicating that a VPP star-level program is an asset to the safety and health of personnel and property.

8 DISTRIBUTION: After the plan is approved by NASA, the Contracting Officer will retain the plan in the contract file. The contractor will send additional copies to each of the following:  
NS/Safety and Test Operations Division (2 copies)  
SD13/Occupational Health Officer (1 copy)  
JE / Environmental Services (1 copy)  
Contracting Officer's Technical Representative (1 copy)

9 INITIAL SUBMISSION: Proposal

10 SUBMISSION FREQUENCY: None, submission only at Proposal

11 REMARKS:  
NOTE: UPON NASA APPROVAL, THE CONTRACTOR'S SAFETY, HEALTH, and ENVIRONMENTAL COMPLIANCE PLAN ('The Plan') BECOMES A CONTRACTUAL REQUIREMENT.  
The following document(s) may be used as guidance:  
• JPR 1700.1: JSC Safety and Health Handbook  
• JSC 17773: Preparing Hazard Analyses for JSC Ground Operations  
• OSHA TED 8.4: Voluntary Protection Programs (VPP): Policies and Procedures Manual

12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 3.2.

13 DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
Establishes Safety, Health, and Environmental Compliance Plan for contractors providing support to NASA Centers.

13.2 APPLICABLE DOCUMENTS:

13.3 CONTENTS:  
1. MANAGEMENT LEADERSHIP AND EMPLOYEE PARTICIPATION.  
1.1. Policy. Provide the contractor's safety, health, and environmental compliance policy statement with the plan. Compare the contractor's policy statement with those of NASA and OSHA and discuss any differences.  
1.2. Goals and Objectives.

## Crew Exploration Vehicle -- (CEV)

- 1.2.1. Describe specific safety and health goals and objectives to be met. Discuss status of safety program using the 'Performance Evaluation Profile' as safety performance criteria. Describe the contractor's approach to continuous improvement (including milestone schedule) using level 5 of the Performance Evaluation Profile as a guideline.
- 1.2.2. Describe Environmental Goals & Objectives to be met for the following:
  - a. Pollution Prevention and Source Reduction of:
    - (1) Hazardous and Industrial Solid Wastes
    - (2) Solid Wastes (trash, refuse)
    - (3) Wastewater Discharges (sanitary sewerage)
    - (4) Air Emissions
    - (5) Medical & Radiological Discharges
  - b. Affirmative Procurement (Purchase of Environmentally Preferable Materials IAW Executive Order)
  - c. Hazardous Materials Handling/Purchasing/Reduction/Replacement
  - d. Elimination from Specifications and Standards requirements for the use of Hazardous/Toxic Substances & Materials
  - e. Use of an Environmental Planning Checklist to review & document Impacts of New and Modified Programs, Projects, Activities and Operations.
  - f. Life cycle analysis and costing
  - g. Incorporating Environmental Requirements in Subcontracts
  - h. Participation in Recycling
  - i. Outreach programs
- 1.3. Management Leadership. Describe management's procedures for implementing its commitment to safety, health, and environmental compliance through visible management activities and initiatives including a commitment to exercise management prerogatives to ensure workplace safety and health. Describe processes and procedures to making this visible in all contract and subcontract activities and products. Include a statement from the project manager or designated safety official indicating that the plan will be implemented as approved and that the project manager will take personal responsibility for its implementation.
- 1.4. Employee Involvement. Describe procedures to promote and implement employee (e.g., non-supervisory) involvement in safety, health, and environmental compliance program development, implementation and decision-making. Describe the scope and breadth of employee participation to be achieved so that approximate safety and health risk areas of the contract are equitably represented.
- 1.5. Assignment of Responsibility. Describe line and staff responsibilities for safety and health program implementation. Identify any other personnel or organization that provides safety services or exercises any form of control or assurance in these areas. State the means of communication and interface concerning related issues used by line, staff, and others (such as documentation, concurrence requirements, committee structure, sharing of the work site with NASA and other contractors, or other special responsibilities and support.) As a minimum, the contractor will identify the following:
  - 1.5.1. Safety Representative - identify by title the individual who will be trained and certified to be responsive to the Center-wide safety, health, environmental, and fire protection concerns and goals, and who will participate in meetings and other activities related to the Center's Safety and Health program
  - 1.5.2. Company Physician/Occupational Injury/illness case manager - identify a point of contact who is responsible for the transfer or receipt of company medical data and who will be the primary contact for the company in the event any employee suffers a work related injury or illness (such as the company physician) by name, address, and telephone number to the the Center's Clinic. This will facilitate communication of medical data to contractor management. Prompt notification to the

Occupational Health/ Clinic shall be given of any changes that occur in the identity of the point of contact. A letter to the Occupational Health Office can accomplish initial identification of point of contact and subsequent updates with a copy sent to the Contracting Officer. The initial letter is to be received by the Government prior to contract start.

1.5.3. Building Fire Wardens - provide a roster of fire wardens (their names, phone numbers and pagers, and mail codes). Contractor fire wardens are needed to facilitate the Center's fire safety program, including coordination of related issues with NASA facility managers and emergency planning and response officials and their representatives. The roster shall be maintained by letter to Center's Occupational Safety Office, with copies to the Contracting Officer and Contracting Officer's Technical Representative. The initial letter shall be received by the Government not later than 15 days after contract start.

1.5.4. Designated Safety Official - identify by title the official(s) responsible for implementation of this plan and all formal contacts with regulatory agencies and with NASA.

1.6. Provision of Authority Describe consistency of the plan for compliance with applicable NASA and Center's requirements and contractual direction as well as applicable Federal, state, and local regulations and how compliance will be maintained throughout the life of the contract.

1.7. Accountability. Describe procedures for ensuring that management and employees will be held accountable for implementing their tasks in a safe and healthful and environmentally compliant manner. The use of traditional and/or innovative personnel management methods (including discipline, motivational techniques, or any other technique that ensures accountability) will be referenced as a minimum and described as appropriate.

1.8. Program Evaluation The program evaluation consists of:

1.8.1. Participation in a Performance Evaluation Profile (PEP) survey at the request of the Government. The PEP survey normally will be scheduled and administered at the discretion of the Government. If the Government chooses not to do the PEP in a given year, the contractor may at its option initiate its own PEP by contacting Center's Occupational Safety Office, for assistance. The contractor will not be required to take two or more PEP surveys in any contract year.

1.8.2. [Reserved.]

1.8.3. A written self-evaluation report to be delivered by Sept 30 of each year. The self-evaluation shall follow the VPP program evaluation report format found in OSHA TED 8.4, Voluntary Protection Programs (VPP) Policies and Procedures Manual, AppendixD, 'Annual Submissions', as mandated by the cognizant OSHA regional office. Contractors who have submitted a written self-evaluation as a VPP site may submit their original report to OSHA in lieu of writing a new self-evaluation provided that all action plans and status are updated. The self evaluation shall as a minimum cover the elements of the approved safety and health plan.

1.8.4. Miscellaneous Reports. The contractor will acknowledge the following as standing requests of the Government and to be handled as described below.

a. Roster of Terminated Employees. Identify personnel terminated by contractor. Send to the Center's Occupational Health Officer, no later than 30 days after the end of each contract year or at the end of the contract, whichever is applicable. At the contractor's discretion, the report may be submitted for personnel changes during the previous year or cumulated for all years. Information required:

(1) Date of report, contractor identity and contract number.

(2) For each person listed, provide name, social security number, and date of termination.

(3) Name, address, and telephone number of contractor representative to be contacted for questions or other information.

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b. Material Safety Data. The contractor shall prepare and/or deliver Material Safety Data for hazardous materials brought onto Government property or included in products delivered to the Government. This data is required by the Occupational Safety and Health Administration (OSHA) regulation, 29 CFR 1910.1200, 'Hazard Communication', EPA 'Emergency Planning and Community Right-to-Know (EPCRA, ref. 40 CFR 302, 311, 312); and Federal Standard 313 (or FED-STD-313), 'Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities', as revised. 1 copy of each MSDS will be sent upon receipt of the material for use on NASA property to the Center's Central Repository, Occupational Health and Test Support, along with information on new or changed locations and/or quantities normally stored or used. If the MSDS arrives with the material and is needed for immediate use, the MSDS shall be delivered to the Central Repository by close of business of the next working day after it enters the site.

c. Hazardous Materials Inventory. The contractor shall compile an inventory report of all hazardous materials it has located on Government property not less than annually, and which is within the scope of 29 CFR 1910.1200, 'Hazard Communication'; and Federal Standard 313 (or FED-STD-313), 'Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities', as revised. The call for this annual inventory and instructions for delivery will be issued by the Center's Occupational Health and Test Support Office. This information shall use the format used by the Center for chemical inventory compilation to provide the following:

- (1) the identity of the material;
- (2) the location of the material by building and room;
- (3) the quantity of each material normally kept at each location
- (4) peak quantity stored
- (5) actual or estimated rate of annual usage of each chemical

1.9. Government Access to Safety and Health Program Documentation. The contractor shall recognize in its plan that it will be expected to make all safety, health, and environmental documentation (including relevant personnel records) available for inspection or audit at the Government's request. Electronic access by the Government to this data is preferred as long as Privacy Act requirements are met and Government safety and health professionals and their representatives have full and unimpeded access for review and audit purposes. For contractor activities conducted on NASA property, the contractor will identify what records it will make available to the Government in accordance with the Voluntary Protection Program criteria of OSHA. For the purpose of this plan, safety, health, and environmental compliance documentation includes but is not limited to logs, records, minutes, procedures, checklists, statistics, reports, analyses, notes, or other written or electronic document which contains in whole or in part any subject matter pertinent to safety, health, environmental protection, or emergency preparedness.

1.10. The contractor may be requested to participate in the review and modification of safety requirements that are to be implemented by the Government including any referenced documents therein. This review activity will be implemented at the direction of the NASA Contracting Officer's Technical Representative in accordance with established NASA directives and procedures.

1.11. Procurement. Identify procedures used to assure that procurements are reviewed for safety, health and environmental compliance considerations and that specifications contain appropriate safety criteria and instructions. Set forth authority and responsibility to assure that safety tasks are clearly stated in subcontracts

1.12. Certified Professional Resources. Discuss your access to certified professional resources for safety, health, and environmental protection. Discuss their roles in motivation/awareness, worksite analysis, hazard prevention and control, and training.

2. WORKSITE ANALYSIS. Hazards shall be systematically identified through

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a combination of surveys, analyses, and inspections of the workplace, investigations of mishaps and close calls, and the collection and trend analysis of safety and health data such as: records of occupational injuries and illnesses; findings and observations from preventive maintenance activities; reports on hazardous substance spills and inadvertent releases to the environment; facilities related incidents related to partial or full loss of systems functions; etc. Hazards identified by any of the techniques identified below shall be ranked and processed. All hazards on NASA property, which are immediately dangerous to life or health, shall be reported immediately to the Occupational Safety Office. All safety engineering products that address operations, equipment, etc., on NASA property will be subject to Center S&MA review and concurrence unless otherwise waived by the Center's Occupational Safety Office.

2.1. Industrial Hygiene. Describe your industrial hygiene program and how it will be coordinated with the Center's government provided resources for industrial hygiene. In the event corporate resources are used to determine workplace exposures, copies of all monitoring data shall be provided to the Center's Occupational Health within 15 days of receipt of results.

2.2. Hazard Identification. Describe the procedures and techniques to be taken to compile an inventory of hazards associated with the work to be performed on this contract. This inventory of hazards shall address the work specified in this contract as well as operations and work environments in the vicinity or in close proximity to contract operations. The results will be reported to the Government in a manner suitable for inclusion in facilities baseline documentation as a permanent record of the facility. Specific techniques to be considered include:

2.2.1. Comprehensive Survey - A 'wall to wall' engineering assessment of the work site including facilities, equipment, processes, and materials (including wastes - (TNRCC/EPA solid & hazardous, radioactive, explosives, medical-infectious-biological)). The comprehensive survey will establish a baseline of hazards that may put contract assets at risk as early as is feasible, preferably at contract start, and maintained throughout the life of the contract.

2.2.2. Change (Pre-use) Analysis - Typically addresses modifications in facilities, equipment, processes, and materials (including waste); and related procedures for operations and maintenance. Change analyses periodically will be driven by new or modified regulatory and NASA requirements.

2.2.3. Hazard Analysis - may address facilities, systems/subsystems, operations, processes, materials (including waste), and specific tasks or jobs. Analyses and report formats will be in accordance with the Center's, 'Instructions for Preparation of Hazard Analyses for Ground Operations'

2.2.4. The contractor's safety plan will describe the flow of the findings of the comprehensive survey of hazards into hazard analyses and job hazard analyses and subsequently into controls such as design, operations, processes, procedures, performance standards, and training. The contractor will discuss its approach to notify NASA and other parties external to the contract work of its identified hazards and subsequent analyses and controls.

2.3. Inspections.

2.3.1. Routine Inspections. Includes assignments, procedures, and frequency for regular inspection and evaluation of work areas for hazards and accountability for implementation of corrective measures. The contractor will describe administrative requirements and procedures for control of and regularly scheduled inspections for fire and explosion hazards. The contractor has the option, in lieu of this detail, to identify policies and procedures with the stipulation that the results (including findings) of inspections conducted on NASA property or



involving Government furnished property will be documented in safety program evaluations or the monthly Accident/Incident Summary reports. Inspections will identify

a. Discrepancies between observed conditions and current requirements, and

b. New (not previously identified) or modified hazards.

2.3.2. Protective Equipment. Set forth procedures for obtaining, inspecting, and maintaining all appropriate protective equipment, as required, or reference written procedure pertaining to this subject. Set forth methods for keeping records of such inspections and maintenance programs.

2.4. Employee Reports of Hazards - identification of methods to encourage employee reports of hazardous conditions (e.g., close calls) and analyze/abate hazards. The contractor will describe steps it will take to create reprisal-free employee reporting with emphasis on management support for employees and describe methods to be used to incorporate employee insights into hazard abatement and motivation / awareness activities.

2.5. Accident and Record Analysis.

2.5.1. Mishap Investigation - identification of methods to assure the reporting and investigation of mishaps including corrective actions implemented to prevent recurrence. The contractor will describe the methods to be used to report and investigate mishaps on NASA property and on contractor or third party property. The contractor will describe its procedures for implementing use of NASA forms as specified and alternate forms used by contractor with emphasis on timely notification of NASA; investigation procedures; exercise of jurisdiction over a mishap investigation involving NASA and other contractor personnel; follow up of corrective actions; communication of lessons learned to NASA; and solutions to minimize duplications in reporting and documentation including use of alternate forms, etc. The contractor will discuss its procedures for immediate notification requirements for fires, hazardous materials releases, and other emergencies. The contractor will include appropriate details to address the use of NASA Form 1627, 'Mishap Report' (or equivalent), including 24-hour and ten-day mishap reports to the Center's Occupational Safety Office. Note: the NASA Form 1627 is not attached since it is a three part carbonless form not conducive to reproduction.

2.5.2. Trend Analysis - describe approach to performing trend analysis of data (occupational injuries and illnesses; facilities, systems, and equipment performance; maintenance findings; etc.) Discuss methods to identify and abate common causes indicated by trend analysis. In support of site-wide trend analysis to be performed by the Government, the contractor will discuss method of providing data as follows:

a. Accident/Incident Summary Report. The contractor shall prepare and deliver Accident/Incident Summary Reports as specified. All new and open mishaps, including vehicle accidents, incidents, injuries, fires, and close calls shall be described in summary form along with current status. Negative reports are also required monthly. Report frequency is monthly; Date due is the 10th day of the month following each month reported. Report to be delivered to the Center's S&MA Directorate through the Safety and Test Operations Division.

b. Log of Occupational Injuries and Illnesses. For each establishment on and off NASA property that performs work on this Contract, the Contractor shall deliver to the Government a copy of its annual summary of occupational injuries and illnesses (or equivalent) as described in Title 29, Code of Federal Regulations, Subpart 1904.5. Copy of all summaries as required above under Contractor's cover letter. If contractor is exempt by regulation from maintaining and publishing such logs, equivalent data in contractor's format is acceptable (such as loss

## Crew Exploration Vehicle -- (CEV)

runs from insurance carrier) which contains the data required. Data shall be compiled and reported by calendar year and provided to the Government within 45 days after the end of the year to be reported (e.g., not later than February 15 of the year following.)

3. HAZARD PREVENTION AND CONTROL. Identified hazards must be eliminated or controlled. In the multiple employer environment of the center, it is required that hazards including discrepancies and corrective actions be collected in a center wide information system (Hazard Abatement Tracking System (HATS) for risk management purposes. Describe your approach to implementing this requirement.

3.1. Appropriate Controls. Discuss approach to consideration and selection of controls. Discuss use of hazard reduction precedence sequence. Discuss approach to identifying and accepting any residual risk. Discuss implementation of controls including verifying effectiveness. Discuss scope of coverage (hazardous chemicals, equipment, discharges, waste, energies, etc.). Discuss need for coordination with safety, health, environmental services, and emergency authorities at NASA.

3.2. Hazardous Operations and Processes. Establish methods for notification of personnel when hazardous operations and processes are to be performed in their facilities or when hazardous conditions are found to exist during the course of this contract. JPR 1700.1 will serve as a guide for defining, classifying, and prioritizing hazardous operations; 29 CFR 1910.119 will be the guide for hazardous processes. Develop and maintain a list of hazardous operations and processes to be performed during the life of this contract. The list of hazardous operations and processes will be provided to JSC as part of the plan for review and approval. NASA and the Contractor will decide jointly which operations and processes are to be considered hazardous, with NASA as the final authority. Before hazardous operations or processes commence, the Contractor will develop a schedule to develop written procedures with particular emphasis on identifying the job safety steps required. NASA will have access on request to any contractor data necessary to verify implementation. For all identified operations or processes that may have safety or health implications outside contract operations, the contractor shall identify such circumstances to the Center's Safety and Test Operations Division and Occupational Health and Test Support Office who will provide additional instructions for further NASA management review and approval.

3.3. Written Procedures. Identification of methods to assure that the relevant hazardous situations and proper controls are identified in documentation such as inspection procedures, test procedures, etc., and other related information. Describe methods to assure that written procedures are developed for all hazardous operations, including testing, maintenance, repairs, and handling of hazardous materials and hazardous waste. Procedures will be developed in a format suitable for use as safety documentation (such as a safety manual) and be readily available to personnel as required to correctly perform their duties.

3.4. Hazardous Operations Permits. Identify facilities, operations and/or tasks where hazardous operations permits will be required, (such as confined space entry, hot work, etc.) Set forth guidance to adhere to established NASA procedures. Clearly state the role of the safety group or function to control such permits.

3.5. Operations Involving Potential Asbestos Exposures. Set forth method by which compliance is assured with the Center's Asbestos Control Program.

3.6. Operations Involving Exposures to Toxic or Unhealthful materials. Such operations must be evaluated by the Center's Occupational Health Office and must be properly controlled as advised by same. The Center's Occupational Health Office must be notified prior to initiation of any new or modified operation potentially hazardous to health.

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## 3.7. Environmental Operations &amp; Activities

3.7.1. Operations Involving Hazardous Waste. Identify procedures used to manage hazardous waste from point of generation through disposal. Clearly identify divisions of responsibility between contractor and NASA for hazardous waste generated throughout the life of the contract. Operations that occur on site at NASA Facilities must be evaluated by the Center's Environmental Services Office and must be properly controlled as advised by same. The Center's Environmental Services Office must be notified prior to initiation of any new or modified operations, equipment, systems, or activities generating new hazardous wastes or where the chemicals change or there are volume increases of 25% or more on site.

3.7.2. Operations Involving New or Modified Emissions/Discharges to the Environment. Set forth methods for identifying new or modified emissions/discharges and coordinating results with the Environmental Services Office. Set forth a plan of procedures to conduct pollution prevention, waste minimization or source reduction/elimination of environmental pollution. Address management and continuous improvement for the reduction of hazardous materials; substitution of non-hazardous or less hazardous materials for hazardous materials; proper segregation of hazardous wastes from non-hazardous wastes; and other methods described by NASA, EPA, GSA, and Executive Order recycled content / affirmative procurement purchases. The Environmental Office is the single point of contact for coordinating all Center environmental permits. Emphasis shall be placed on providing for sufficient lead time for processing permits through the appropriate state agency and/or the Environmental Protection Agency.

3.8. Discuss your responsibilities for maintaining facilities baseline documentation in accordance with Center's requirements. The contractor will implement any facilities baseline documentation tasks (including safety engineering) as provided in the contractor's plan approved by NASA or as required by Government direction.

3.9. Preventive Maintenance. Discuss approach to preventive maintenance. Describe scope, frequency, and supporting rationale for your preventive maintenance program including facilities and /or equipment to be emphasized or de-emphasized. Discuss methods to promote awareness in the NASA community (such as alerts, safety flashes, etc.) when preventive maintenance reveals design or operational concerns in facilities and equipment (and related processes where applicable).

3.10. Medical (Occupational Healthcare) Program. Discuss your medical surveillance program and injury /illness case management to evaluate personnel and workplace conditions to identify specific health issues and prevent degradation of personnel health as a result of occupational exposures. Discuss approach to Cardiopulmonary Resuscitation (CPR), first aid, and return to work policies and the use of government provided medical and emergency facilities for the initial treatment of occupational injuries/illnesses.

3.11. Hazard Correction and Tracking. Discuss your system for correcting and tracking safety, health, and environmental hazards with particular emphasis on integration with the Center's Hazard Abatement Process. (The scope is restricted to establishments at the various Centers) This includes the following:

3.11.1. Personnel awareness of hazards. Discuss your approach to communicate unsafe conditions and approved countermeasures to your employees. Discuss your approach to communicating such conditions to the Government and other contractors whose personnel may be exposed to such unsafe conditions. Discuss communications with facility managers. Discuss use of the NASA Lessons Learned Information System for both obtaining lessons from other sources and as a repository for lessons learned during performance of the contract.

3.11.2. Interim and Final Abatement Plans. Describe how you will approach interim and final abatement of hazards. Describe how you will

## Crew Exploration Vehicle - (CEV)

provide data to the Center's Hazard Abatement Tracking System for all hazards that are not finally abated (all interim and final abatement actions completed) within 30 days of discovery. Discuss your approach to posting such plans. Discuss compatibility of your system with the role of facility managers in abatement planning, implementation, and verification.

3.12. **Disciplinary System.** Describe your system for ensuring safety and health discipline in your personnel (including subcontractors). Describe your approach to modifying personnel behaviors when personnel are exhibiting discrepant safety and health performance.

3.13. **Emergency Preparedness.** Discuss approach to emergency preparedness and contingency planning which addresses fire, explosion, inclement weather, environmental spill /releases, etc. Discuss compliance with 29 CFR 1910.120 (HAZWOPER) and role in the Center's Incident Command System. Discuss methods to be used for notification of JSC emergency forces including emergency dispatcher, safety hotline, director's safety hotline, etc. Discuss establishment of pre-planning strategies through procedures, training, drills, etc. Discuss methods to verify emergency readiness.

4. **SAFETY AND HEALTH TRAINING.** Describe the contractor's training program including identification of responsibility for training employees to assure understanding of safe work practices, hazard recognition, and appropriate responses for protective and/or emergency countermeasures, including training to meet federal, state, and local regulatory requirements. In doing so, the contractor will factor parallel requirements found in other mandates such as environmental protection [example: 29 CFR 1910.38 for emergency action plans and fire prevention plans versus EPA Resource Conservation & Recovery Act (RCRA) for Emergency Planning and Community Right-to-know (EPCRA).] Describe approach to identifying training needs including traceability to exercises such as job safety analyses, performance evaluation profiles, hazard analyses, mishap investigations, trend analyses, etc. Describe approach to training personnel in the proper use and care of protective equipment (PPE). Discuss tailoring of training towards specific audiences (management, supervisors, and employees) and topics (safety orientation for new hires, specific training for certain tasks or operations). Discuss approach to ensure that training is retained and practiced. Discuss personnel certification programs. Certifications should include documentation that training requirements and physical conditions have been satisfied (examples include physical examination, testing, and on-the-job performance). Address utilization of JSC safety and health training resources (such as asbestos worker training/certification, hazard communication, confined space entry, lockout/tagout, etc.) as appropriate with particular emphasis on programs designed for the multiple employer work environment on NASA property. All training materials and training records will be provided to NASA, and other federal, State, and local agencies for their review upon request. If the contractor wishes to train their personnel in any regulatory mandated training, an agreement will be secured with the Occupational Safety Branch and Occupational Health and Test Support office prior to beginning training. The agreement will ensure that safety and health training resources available from NASA are utilized where appropriate and to ensure that contractor-supplied training is in agreement with the Center's safety and health processes.

- 13.4 **FORMAT:** 1. Cover page - to include as a minimum the signatures of Contractor's project manager and designated safety official (if different); NASA COTR; The Center's Occupational Safety Branch; and the NASA Contracting Officer. Other signatures may be required at the discretion of the Government.

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2. Table of Contents. See content below
  3. Body of plan - as required. Contractor's format is acceptable but should be traceable to the elements of the content below
  4. When preparing its plan, the offeror/contractor is expected to review all the items below and tailor its plan accordingly. Certain requirements set forth in this DRD may be specific for contractor operations performed at NASA Centers; tailoring of the plan to the requirements of specific establishments is acceptable. The plan will clearly identify those resources to be provided by the contractor and provided by the Government. This review and supporting rationale is to be made available to the Government as part of this plan. It can be documented as a checklist or outline, inserted directly in the body of the plan, or in any format developed by the contractor that clearly conveys the results of this review including the basis for any underlying assumptions
- 135 **MAINTENANCE**: Subsequent revisions to the plan. The contractor may revise the plan at any time or at the direction of the Government. Revisions are subject to Government review and approval. Distributions of approved revisions will be as described above.

1	<b>PROGRAM:</b> CEV	2.	<b>DRD NO.:</b> CEV-S-009
3.	<b>DATA TYPE:</b> 1/3	4	<b>DATE REVISED:</b> 12/20/2005
		5	<b>PAGE:</b> 1
6.	<b>TIITLE:</b> Failure Modes Effects Analysis & Critical Items List (FMEA/CIL)		

The Failure Modes Effects Analysis is a design tool and will be used to aid design engineering, operations, and manufacturing of the CEV. The Contractor shall perform Failure Modes and Effects Analysis (FMEA) - to identify and determine possible modes of failures (including hardware failures, software failures and human errors), the effects of such failures, and the criticality of such failures to support

- The purpose of the Critical Items List (CIL) is to identify those items or hardware that do not meet failure tolerance requirements (CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD), para's 3.3.7.1, 3.3.7.2, 3.3.7.3, 3.3.7.4) and, in addition, those items that do not pass the redundancy screens (screening to determine if an item's redundant path can be functionally verified or if a redundant path failure can be detected prior to use, or if all redundant paths can be lost as a result of single credible common failure cause) that require special attention when establishing hardware specifications and qualification requirements.

8. **DISTRIBUTION:** As determined by the Contracting Officer

9 **INITIAL SUBMISSION:** Initial submission at System Definition Review (see remarks for content)

10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix

11. **REMARKS:**

At System Definition Review the following level of maturity is required:

- (a) The contractor shall develop and document preliminary System level Reliability Block Diagrams (RBDs) (Logic Diagrams which graphically depict items, configured in single or redundant paths, that must work for the defined function to be completed successfully and to assess the System failure tolerance) of the CEV System, its modules, the subsystems, and their functions, major mission phases or modes identified.
- (b) Master logic diagrams, functional failure modes defined, preliminary high level (System and Spacecraft level) failure effects identified.

At Preliminary Design Review the following level of maturity is required:

- (a) Detailed Subsystem and component level RBDs matching the detail of equipment lists from the CEV System Contractor.
- (b) Failure mode effects will describe the out-of-spec outputs (including higher level spacecraft and System effects) required to support failure propagation assessments.
- (c) Lowest level effects (subsystem and component level) accurately propagated to the high level (System and spacecraft) effects.
- (d) Failure causes sufficiently developed to a level commensurate with the design.
- (e) Failure effects developed to a level consistent with design detail, for both hardware and software

Note: To enable more timely evaluation to the design effort, informal FMEA and CIL submittals to Technical Interchange Meetings (TIMs) with NASA subsystem engineers will be provided periodically prior to the PDRs, outside of the PDR review process.

At Critical Design Review (CDR) the following level of maturity is required:

- (a) System and Component Level FMEA and CIL complete.
- (b) Detailed subsystem and component level RBDs complete.
- (c) FMEA and CIL completed analysis to the deepest level of indenture (component level) for the analysis.
- (d) Failure mode effects complete to the lowest level (component level).
- (e) Failure Causes sufficiently developed to a level commensurate with the design.

Following CDR, the FMEA and CIL results shall be of sufficient quality, level of detail and timeliness to be used to develop test plans and to troubleshoot test failures. The FMEA database shall be maintained as needed to document design and operational changes, to document new content as well as to capture belatedly recognized failure modes and effects.

12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 3.3.

Referenced from SOW Paragraph(s): 9.2

Related DRD(s): CEV-S-001, CEV-S-002, CEV-S-003, CEV-S-010, CEV-S-011

13. **DATA PREPARATION INFORMATION:**

13.1 **SCOPE:**

The FMEA is an analysis for the CEV System to determine possible modes of failure and their effects on the crew, spacecraft and mission success, with the provisions for identifying each failure mode by its Criticality category number. A FMEA shall be prepared for each CEV System and subsystem to the component level (described in 13.3).

The CIL is a list of hardware identified in the FMEA categorized as being 'Critical', i.e., those items whose failure could result in a loss of life, the vehicle, and the mission. The Critical Items List shall consist of those failure modes identified by the FMEA that are

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Criticality 1, Criticality 2, all Criticality 1R items where the next failure of any redundant item could cause loss of the crew, and all Criticality 1R and 2R items that fail one or more redundancy screens. The FMEA and CIL worksheet documents (objectively) the 'retention rationale' for the design features, testing, and inspections, operational use, maintainability, and includes the failure history of the item to help minimize the failure occurrence probability. CIL worksheets shall be documented as open (not approved by the NASA Project) until the request for CEV Project acceptance has been approved. Maintenance of the CEV FMEA and CIL will be limited to changes of the System, subsystem, or components as required, to aid in design, operation, and manufacturing decisions, to document new content as well as to capture belatedly recognized failure modes and effects.

13.2 **APPLICABLE DOCUMENTS:**

CXP-02019: Constellation Program Requirements for Preparation of Hardware FMEA/CIL  
CXP-10001: Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD)

13.3 **CONTENTS:**

- a. A brief System and subsystem overview shall be provided along with a subsystem level Reliability Block Diagram (RBD) to reflect the configuration and details of the systems.
- b. FMEA worksheets shall be prepared at the lowest level (component level) required to support potential uses (redesign, testing, failure reporting or corrective action, preparation of mandatory inspection points), in accordance with Document CXP-02019, Constellation Program Requirements for Preparation of Hardware FMEA/CIL.
- c. FMEA and CIL worksheets shall be prepared as appropriate (with regard to Criticality) with 'retention rationale' that contains data that supports the premise that the risk presented by inclusion of the item in the assembly/subsystem/spacecraft/System/CEV has been minimized by proper design controls, inspections, tests, critical processes and maintenance controls, and that no adverse failure history exists. The rationale shall also contain data, which describes operational constraints caused by occurrence of the failure, and describe the measures taken to ensure that the function is restorable. The contractor shall also prepare as part the verification activity, an entry on the worksheet, that lists the methods for verifying CIL 'retention rationale' and hazards control activity. Ground rules shall be consistent with sections 4 and 5 of CXP-02019, Constellation Program Requirements for Preparation of Hardware FMEA/CIL.
- d. The fidelity of the FMEA and CIL shall reflect the latest hardware and software designs and identify risks for all flight software and hardware and its interactions during various phases of the program per the scope as listed in par. 13.1. If the contractor determines that future FMEA and CIL submissions should separate hardware and software, this can be accomplished by separate chapters within the analysis, however, there must be a final system FMEA and CIL that ties the hardware and software interactions together as often the two are used in concert to obtain adequate fault and failure tolerance.
- e. A 'single point' failure summary shall be provided as a section of the CIL. An independent redundant items failure analysis shall be done for Critical Items to evaluate the potential effects for latent defects and other process issues including potential human errors. The FMEA and CIL analysis shall cover Common Cause Failure (CCF) Analysis at the Systems and subsystems level and CCF shall be designed out to an acceptable risk level (as approved by the NASA Project) and residual risks shall be documented and controlled.
- f. The FMEA and CIL analysis shall cover Common Cause Failure (CCF) Analysis at Systems and subsystems level and CCF shall be designed out to



an acceptable risk level (as approved by the NASA Project) and residual risks shall be documented and controlled.

- 13.4 **FORMAI**: Electronic format per Section J-2 2.3.2 1..
- 13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Only changes or updates to the baselined FMEA and CILs shall be resubmitted for NASA approval.

1 PROGRAM: CEV 2 DRD NO.: CEV-S-010  
3 DATA TYPE: 1 4. DATE REVISED: 12/20/2005  
5. PAGE: 1  
6 TITLE: Probabilistic Risk Assessment Results  
7 DESCRIPTION/USE:  
To define and document the contractor's data and findings in implementing and performing a Probabilistic Risk Assessment (PRA) per the Constellation PRA Plan.  
8 DISTRIBUTION: As determined by the Contracting Officer  
9 INITIAL SUBMISSION: Per Data Requirements Matrix  
10 SUBMISSION FREQUENCY: Per Data Requirements Matrix  
11 REMARKS:  
Preliminary PRAs are due at System Definition Review to current design level of detail. Event trees, fault trees, model integration & quantification, and uncertainty analysis shall be under development. Included with the PRAs, ground rules, mission success criteria, end states shall be ready to baseline.  
At Preliminary Design Review (PDR) the following level of maturity is required:  
(a) Changes to Event trees, fault trees, model integration & quantification, and uncertainty analysis from System Definition Review status.  
(b) Risk scenario development complete.  
(c) Event sequence Diagram complete.  
(d) Master Logic diagrams complete.  
(e) Initiating events updated to PDR level of detail using available hazard analysis.  
At Critical Design Review (CDR) the following level of maturity is required:  
(a) Initiating events updated to CDR level of detail using available hazard analysis.  
(b) Event trees, fault trees, model integration & quantification, and uncertainty analysis development continued.  
(c) Changes to previous submittals addressed.  
Following CDR, updates shall include the following:  
(a) Analyses complete and should be high level of detail and maturity with accurate test-supported input data.  
(b) Update with changes to the design.  
(c) Changes to previous submittals addressed.  
The following documents may be used as guidance documents:  
(a) Probabilistic Risk Assessment Procedures Guide for NASA Managers and Practitioners, (August 2002), Chapters 4-14  
(b) Fault Tree Handbook with Aerospace Applications (August 2002), NASA HQ OSMA, Chapters 1-9  
The following document(s) may be used as guidance:  
• CXP-02004: Constellation Probabilistic Risk Assessment (PRA) Plan  
• FTH: Fault Tree Handbook with Aerospace Applications, August 2002,

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version 1.1 (Chapters 1-9)

• PRAPG: Probabilistic Risk Assessment Procedures Guide for NASA Managers and Practitioners, Sections 4 - 14

12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 3.3  
Referenced from SOW Paragraph(s): 1.1.6, 3.2  
Related DRD(s): CEV-S-001, CEV-S-002, CEV-S-009, CEV-S-011

13. **DATA PREPARATION INFORMATION:**

13.1 **SCOPE:**

The Contractor shall develop the CEV PRA per CXP-02004, Constellation Probabilistic Risk Assessment (PRA) Plan and the Probabilistic Risk Assessment Procedures Guide for NASA Managers and Practitioners, (August 2002), chapters 4-14. The CEV Probabilistic Risk Assessment Results shall include the models, basis for the models, analysis results, detailed descriptions of the analysis, justifications for assumptions, data, and basis for the data. The models, analysis, and data used will comply with the requirements in the Constellation PRA Plan.

(a) Probabilistic Risk Assessments (PRAs) shall be used to model potential accident scenarios during each Design Reference Mission to determine the reliability and risk of each CEV design concept.

(b) Success or failure of a CEV mission shall be directly related to 'end states' in the PRA analyses. Additional end states can be included in the analysis as desired by the program.

(c) Perform comprehensive function analysis to identify all system functions necessary for the system to achieve its operational objectives for the Design Reference Missions in the specified mission environments. Function analysis should include functions that will be performed by hardware, software, and people.

(d) Develop Function Flow Diagrams to illustrate flow of information and processing required. The functional flow diagrams shall illustrate all interrelationships between function interfaces. The interrelationships shall be evaluated to determine if an interface failure results in a PRA end state.

(e) PRA models shall be graphically illustrated in top-level fault trees called Master Logic Diagrams (MLD), in which the top level blocks are the end states (or FOM), the intermediate blocks represent the chain of events necessary to produce the end states, and the bottom blocks are the initiating events.

(f) The CEV PRA shall identify important initiating events that can trigger failures/events for each series of end states. Initiating events shall include hardware failures, software failures, human errors, and naturally occurring phenomena. Internal initiators as well as external initiators (e.g., MMOD) shall be considered.

(g) The CEV PRA shall include human reliability analysis (HRA) for both pre-initiating events and post-initiating events, including those modeled in support system initiating event fault trees. The HRA should comply, at a minimum, with the high level requirements as outlined in ASME RA-S-2002: Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications or an equivalent document.

(h) The CEV PRA shall include quantitative evaluations of the probability that the initiating events will lead to end states corresponding to CEV success or failure.

(i) The CEV PRA analyses shall incorporate parametric common-cause failure techniques in the system failure analysis models and failure probability evaluations.

(j) The CEV PRA analyses shall include an evaluation and description of quantitative uncertainties.

(k) To the extent feasible, CEV Probabilistic Risk Assessments shall include analysis of software system safety, reliability and quality.

(l) The processes and techniques provided in the PRA Guidebook for NASA Managers and Practitioners shall be used for conducting PRAs.

- (m) Uncertainty analysis shall be performed on the CEV Project PRA to provide the decision maker with a full appreciation of the overall degree of uncertainty about the PRA results and an understanding of which sources of uncertainty are critical to the results that guide decisions.
- (n) Results and Insight from the CEV PRA shall be utilized to update the design, operating, and implementation plans.
- (o) All mission scenarios leading to crew fatality or permanent disability shall have a quantitative risk assessment developed.
- (p) The CEV risk assessment model shall be maintained throughout the system life cycle.

13.2 **APPLICABLE DOCUMENTS:**

13.3 **CONTENTS:**

1. The CEV Probabilistic Risk Assessment Results shall use the applicable document processes and techniques in 13.2 to provide the following:
  - a. Groundrules and assumptions (inputs).
  - b. Models/Data sources.
  - c. Missions, Phases Analyzed
  - d. Values calculated.
  - e. Model/Data Sources.
  - f. Analysis results.
  - g. Risk estimates.
  - h. Risk breakdown with relative contributions.
  - i. Sensitivity analyses.
  - j. Validation or benchmark of methodology and code.
2. The CEV PRA shall be performed per the processes and techniques provided in the PRA Procedures Guide for NASA Managers and Practitioners, chapters 4-14.
3. The Contractor shall identify the major contributors to risk as determined by the CEV PRA.
4. The CEV PRA shall be balanced, comprehensive and tailored.
5. The Contractor shall perform uncertainty analysis on their PRA as part of their reporting of the PRA results and identify those sources which are critical to Program/Project risk decisions.
6. The CEV PRA shall identify and evaluate potential scenarios leading to undesired consequences.
7. The CEV PRA shall evaluate the failure (type and probability) of each event in the potential scenarios leading to undesired consequences (see 4.)
8. The CEV PRA shall quantify the scenarios established for the CEV by the CEV Project PRA plan.
9. The Contractor shall include the degree of uncertainty about the CEV PRA results and an understanding of which sources of uncertainty are critical.
10. The Contractor shall supply all data analyses in support of the quantification of the CEV PRA.
11. The Contractor shall use terminology that is consistent with that used by the CEV Project in the CEV PRA.

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

- 13.5 MAINTENANCE: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-S-011
3. **DATA TYPE:** 1
4. **DATE REVISED:** 12/20/2005
5. **PAGE:** 1
6. **TITLE:** Reliability, Maintainability, and Supportability Integrated Report
7. **DESCRIPTION/USE:**

The Contractor shall design-in Reliability, Maintainability, and Supportability (RMS) as part of the design process for the CEV System throughout the system's design cycle. The Contractor shall present the results of RMS system analysis that integrate the various quantitative and qualitative system level activities within reliability, maintainability, and supportability with other data and system analyses, including allocations and predictions, to the functional 'box' level. Integrated RMS includes processes and tools to predict, evaluate, analyze, track, and integrate RMS Key Performance Parameters (KPPs) with design and other data and system analyses throughout all phases of the project. The purpose of the RMS analysis process is to assess the extent of meeting the project goals and requirements for safety and mission success and to provide the process and tools to predict, evaluate, analyze, track, and integrate RMS parameters with other data and system analyses, as well as provide input for the life cycle cost, throughout all phases of the project. The Probabilistic Risk Assessments (PRAs) will serve as a major element of the quantitative risk estimation process.

The RMS Integrated Report shall include any functions where Design for Minimum Risk (DFMR) would be used in lieu of fault tolerance, where adding additional redundancy is not technically feasible or where redundancy would negatively impact overall system safety and reliability. This report shall include the rationale for acceptance of these DFMR functions.

The RMS Integrated Report shall consist of five volumes, one each for Reliability, Maintainability, and Supportability, one for DFMR, and one integrated report. Each volume shall include data, tool descriptions, and analyses descriptions as well as the specific requirements as listed in section 13 of this DRD.
8. **DISTRIBUTION:** As determined by the Contracting Officer
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**

Initial draft of this report shall be submitted prior to Systems Requirements Review, providing high-level system Reliability, Maintainability and Supportability allocations. At System Definition Review, Preliminary Design Review, Critical Design Review, Flight Readiness Review, updates shall be provided incorporating increasing detail as design becomes firm.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 3.3.  
Related DRD(s): CEV-S-001, CEV-S-002, CEV-S-009, CEV-S-010, CEV-T-011, CEV-T-012
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**

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The Reliability, Maintainability and Supportability (RMS) Analysis Integrated Report shall be performed in accordance with 13.2 applicable documents to provide the following:

- (a) Details of Reliability Analysis - quantitative and qualitative analyses
- (b) Details of Maintainability Analysis - quantitative and qualitative analyses
- (c) Details of Supportability Analysis - quantitative and qualitative analyses
- (d) The integration of RMS quantitative and qualitative analyses and the trade studies
- (e) Description and discussions of all RMS analyses results including sensitivity analyses.
- (f) Integration of RMS results including input/output process and the integration of RMS with design engineering, systems engineering and cost analyses, including sensitivity analyses across RMS parameters.
- (g) Impact of RMS analyses results on system design in improving RMS goals while optimizing the system safety and mission success.
- (h) Reference data sources and modifications.
- (i) Verification and validation of models/data.

**13.2 APPLICABLE DOCUMENTS:**

CXP-02012: Methodology For Conduct of Project Constellation Hazard Analyses  
CXP-02019: Constellation Program Requirements for Preparation of Hardware FMEA/CIL

**13.3 CONTENTS:**

The individual Reliability, Maintainability and Supportability (RMS) Analysis/Report shall consist of the following:

1. Reliability report shall document the reliability data, tools, and analyses (including groundrules and assumptions) used to show concurrence or deviation with the applicable CEV Systems Requirements at each step in the design cycle. The data generated from the reliability analyses shall provide input to the systems maintainability, supportability, and availability analyses. Details of the Reliability Report shall include the following:
  - (a) Provide Reliability Block Diagram (RBD) (Logic Diagrams which graphically depict items, configured in single or redundant paths, that must work for the defined function to be completed successfully and to allow assessment of the System failure tolerance) and reliability allocation and predictions report. Using reliability analysis, provide details of the key improvement process leading to robust design of flight hardware and software, especially key LRUs.
  - (b) Provide details of reliability roadmap, supported by specific reliability growth plan, for key items to meet short term and long term requirements to meet project and mission needs.
  - (c) Identify the candidates for Probabilistic Design Analysis (PDA) and structural reliability. Provide the analysis and recommendation.
  - (d) Provide details of reliability growth process and goals, planned reliability demonstration testing to ascertain physics of failure for better understanding of design uncertainties, design margins, safety factors, and design qualification testing, etc.
  - (e) Provide a roadmap for evolution of design maturity to minimize risk, project schedule and cost. Include gap analysis if appropriate.
  - (f) Include the worst case environmental conditions for the flight hardware for each respective mission phase and through the entire mission.
  - (g) Supplement reliability prediction with Probabilistic Risk Assessment (PRA) approach for the calculation of applicable quantitative Constellation Program requirements needing uncertainty on parameter estimates.

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(h) Clear definition on the linkage between the PRA and other supporting reliability analyses.

2. The Maintainability Report shall document the maintainability data, tools, and analyses (including groundrules and assumptions) used to show concurrence or deviation with the applicable CEV System requirements at each step in the design cycle. The data generated from the maintainability analyses shall provide input to other systems analyses such as availability, supportability and cost. Maintainability allocations shall flow from the maintenance concept (Ref. DRD CEV-T-011) developed and the reliability prediction. This shall identify the process, engineering rationale and trade studies to decide the number of Line Replaceable Units (LRU) and the justification of that number. Details of Reliability Centered Maintenance (RCM) and optimum levels of maintenance along with necessary justification shall be provided. Details of quantitative and qualitative Maintainability Analysis/Report shall:

- (a) Provide basis and decision process used to decide the number of LRU for each subsystem and system and the supporting justification.
- (b) Provide complete details of the trade study to decide the optimum maintenance levels for key flight software components and hardware LRUs, its underlying groundrules, assumptions and justification of the final recommendation to optimize the life cycle cost
- (c) Provide reliability and maintainability assessment results for each mission phase including Mean Time to Failure (MTTF), Mean Time Between Failure (MTBF) and Mean Time Between Maintenance Events (MTBME) information, as applicable, for each LRU/subsystem/ system. For software components, collect appropriate fault and failure data and any fixes.
- (d) Provide other details such as MTTF, MTBF and MTBME for each LRU/subsystem and system using failure rate information of each component as applicable, reliability assessment using engineering and physics based models, data from demonstration testing and other supporting information etc. to analyze the various subsystems/LRUs of the system throughout its life cycle.
- (e) The Contractor shall include the combination of the active time to repair and the logistics or administrative downtime that affects the ease or rapidity of achieving full restoration of the lost function.

3. The Supportability Report shall document the supportability data, tools, and analyses (including groundrules and assumptions) used to show concurrence or deviation with the applicable CEV System requirements at each step in the design cycle. Supportability shall include analyses of systems availability and shall use guidelines of the performance based supportability principles. The analyses used will support the design-for-supportability process and will determine the total resources necessary to support the maintenance of each system and the overall Constellation Program for their operational life. Data generated will be used as input into other systems analyses such as cost and other trade studies.

The DFMR Report shall include:

1. Any functions where DFMR would be used in lieu of fault tolerance, where adding additional redundancy is not technically feasible or where redundancy would negatively impact overall system safety and reliability.
2. The rationale for acceptance of these DFMR functions.
3. The data used to arrive at the recommendation and the technical design, manufacturing, and verification standards or techniques that will be employed to minimize the risk of failure for DFMR items.

The Integrated RMS Report shall include:

1. RMS results, such as sensitivity analyses and trade studies along with applicable groundrules and assumptions.
2. Integration of RMS results including input/output process and the integration of RMS with other engineering analyses including sensitivity analyses across RMS parameters.



3. Impact of RMS analyses results on system design and design engineering.
  4. Details of improving RMS goals while optimizing the system/subsystem life cycle cost.
  5. Relative contributions to each RMS parameter resulting from specific systems and subsystems.
  6. Data sources and modifications.
  7. Validation of reliability, maintainability and supportability models/data.
  8. All verification and validation activities shall be reported.
- 13.4 **FORMAT**: Electronic format per Section J-2 2.3.2 1.
- 13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required

1 PROGRAM: CEV 2 DRD NO.: CEV-S-012  
3 DATA TYPE: 1/2 4 DATE REVISED: 12/20/2005  
5 PAGE: 1

6 TITLE: Government-Industry Data Exchange Program and NASA  
Advisories/ALERTS

7 DESCRIPTION/USE:  
To provide a controlled method for CEV Project and Contractor ALERT  
initiation, investigation, resolution, and response. The types of data  
include:  
(a) Contractor and subtier implementation procedures  
(b) Preparation and submittal of GIDEP documents.  
(c) Preparation and submittal of NASA Advisories.  
(d) Task management, control, and tracking status.  
(e) Cost data on special problems (involving criminal investigations).

8 DISTRIBUTION: As determined by the Contracting Officer

9 INITIAL SUBMISSION: Data shall be submitted as follows:  
(a) The Contractor and subtier Implementation procedures (60 days after  
contract award)  
(b) Release of GIDEP documents (in compliance with GIDEP Operations  
Manual and Policy)  
(c) Release of NASA Advisories (in accordance with NASA policy)  
(d) Problem data assessments (30 days after receipt of the problem data).  
(e) Cost data on special problems (involving criminal investigations).

10 SUBMISSION FREQUENCY: As required

11 REMARKS:  
Contractor must provide NASA the name and contact details of the  
Contractor's ALERT Coordinator, within 30 days of contract award.

12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 3.3.

13 DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
The CEV project ALERT System Documentation provides information relative  
to unexpected failures or discrepant conditions of parts and materials  
used in equipment that may be of significant application in other  
equipment and to safety problems of general concern. This applies to  
failures or discrepant conditions encountered when such parts or  
materials are applied within the limits of the applicable specification.  
Generic problems experienced by the project or by program assesses shall  
be reported in the GIDEP or NASA Advisory Network, as appropriate.  
Management documentation shall be adequate to ensure that:  
(a) the subject problem data are received, properly distributed, and  
thoroughly assessed for potential impact  
(b) identified impact issues are resolved or corrected with NASA program  
management concurrence  
(c) cost data for special problem issues are accumulated and reported  
(d) all this information is captured and retained in a database.

Attachment J-2  
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GIDEP ALERTS, GIDEP SAFE-ALERTS, GIDEP Problem Advisories, GIDEP Agency Action Notices, and NASA Advisories are 1) reviewed and dispositioned, 2) ensure that all significant parts, material and safety problems of a general concern are identified and corresponding data are exchanged with this system, and 3) present the status of all applicable items for review at program milestones and readiness reviews in accordance with the S&MA Plan (DRD CEV-S-001).

132 APPLICABLE DOCUMENTS:

S0300-BT-PRO-010: Government-Industry Data Exchange Program (GIDEP) Operations Manual

133 CONTENTS:

## A. Implementation Procedures:

The contractor and sub contractor implementation procedures shall provide details that will ensure that the contractor understands and will implement these procedures, which cover the scope; task importance; management responsibilities; technical expertise to identify and resolve any impacts; 'special problem' information sensitivity; and documentation necessary to comply with GIDEP and NASA policies.

## B. NASA Advisories and Alerts:

ALERTs shall be prepared and responded to in accordance with S0300-BT-PRO-010 and include:

(a) Contractor initiated ALERTs - The proposed ALERT shall include, but not be limited to:

1. Essential details required identifying problem by types and/or manufacturer's name, special requirements and environments, the problem situation (condition) and cause, actions taken and recommendations. Such data shall be restricted to objective, factual information.

2. Names of responsible individuals and organizations that may be contacted for further technical details.

3. Upon CEV Project approval, contractor initiated ALERTs that are of general concern shall be submitted to NASA (JSC NASA Advisory Coordinator) for determination of whether this is to be a GIDEP type alert (GIDEP ALERT, GIDEP SAFE-ALERT, GIDEP PROBLEM ADVISORY, or GIDEP AGENCY ACTION NOTICE) or a NASA Advisory. If it is determined that this is a GIDEP type alert, NASA (JSC NASA Advisory Coordinator) will provide the appropriate GIDEP form to the contractor for completion. After the appropriate legal review by NASA, this form will be submitted to the Government-Industry Data Exchange Program (GIDEP) for dissemination to all participants. Proposed ALERTs that only concern NASA will be disseminated to the NASA community by the JSC NASA Advisory coordinator.

4. If it is determined by NASA (JSC NASA Advisory Coordinator) that this information is limited to NASA only, the contractor will be provided JSC NASA Advisory Form, JSC Form 1159 for completion.

(b) Response reports for ALERT disseminated by CEV Program (JSC NASA Advisory Coordinator):

1. The contractor shall respond to ALERTs disseminated by the CEV Program (JSC NASA Advisory/Alert Coordinator) with one of the following three categories:

- (a) No Impact
- (b) Usage with No Impact
- (c) Usage with Impact

2. If the response is Usage with Impact, NASA Form 1544 will be completed. Some of the items to be addressed in this form shall identify the hardware to which the response applies and identify the ALERT #, the part numbers affected, the system affected, give an analysis of the problem, and a narrative recommendation and/or corrective actions.

accomplished

3. Follow-on-Reports results of investigations, analyses, etc. extended beyond the 21 working days allowed for the initial report (may closeout ALERT if no corrective action required).

4. No response required on ALERTs marked 'Information Only' unless an impact is identified.

- 13.4 **FORMAT:** (a) The Contractor's format is acceptable for their internal implementation procedures.  
(b) GIDEP documents are to be prepared on the appropriate GIDEP form found in the GIDEP Operations Manual.  
(c) NASA Advisories are to be prepared on the JSC NASA Advisory Form, JF 1159.  
(d) The contractor's format is acceptable for providing the 'Task Management, Control, and Tracking Status' as long as it includes all the necessary information. An electronic database with access permission to appropriate NASA personnel is preferred.  
(e) Cost data are to be provided as required by the financial management reporting system and as necessary to substantiate the data being submitted in support of criminal investigations  
(f) Contractor Initiated ALERT - The proposed ALERT shall be submitted to the project's S&MA representative with a copy to the CEV Project ALERT coordinator (JSC NASA Advisory Coordinator). Preliminary ALERTs may be issued by using a GIDEP AGENCY ACTION Notice (GIDEP Form 97-3) when immediate notification of the NASA community is considered urgent, and time or insufficient technical detail will not allow completion of the ALERT. Upon approval, the initiator shall follow GIDEP procedure for dissemination of the completed ALERT to all GIDEP participants.
- 13.5 **MAINTENANCE:** Data shall be maintained as required to:  
(a) Document the current implementation procedures and GIDEP and NASA Advisory Policies  
(b) Ensure that the released GIDEP information is complete, factual, accurate and up to date.  
(c) Ensure that the released NASA Advisory information is complete, factual and up to date.  
(d) Tracking status provided periodically to demonstrate complete accomplishment of the task.  
(e) Stay current and accurate or as requested to support management activities.  
(f) Substantiate submitted costs or to include additional costs as they are intended.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-S-013
3. **DATA TYPE:** 1/2/3\*
4. **DATE REVISED:** 12/20/2005
5. **PAGE:** 1
6. **TITLE:** Problem Reporting and Corrective Action (PRACA) Reports
7. **DESCRIPTION/USE:**  
The Contractor shall report, evaluate, track, trend, process and disposition CEV-related hardware and software problems into the NASA Constellation problem data system.
8. **DISTRIBUTION:** As determined by the Contracting Officer
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** PRACA reporting begins with the manufacturing of flight or flight-like hardware and software.
11. **REMARKS:**  
\*Data Type  
Initial Report is Data Type 2;  
Preliminary Report is Data Type 3  
Close-Out/Explanation is Data Type 1  
  
PRACA problem reporting shall begin once manufacturing has begun of flight or flight like hardware/software.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 3.4.
13. **DATA PREPARATION INFORMATION:**
  - 13.1 **SCOPE:**  
This data requirement establishes a standard closed-loop process for handling CEV Project hardware, software, and ground support equipment problems.  
  
Evaluation for PRACA problem reporting shall begin once manufacturing has begun of flight or flight-like hardware/ software leading to at least one of the following manufacturing levels:  
(a) First instance of qualification testing for the Orbital Replacement Unit (ORU), Line Replacement Unit (LRU), or Shop Replacement Unit (SRU) has started.  
(b) First instance of ORU/LRU/SRU acceptance testing has started.  
(c) First instance of primary or secondary structure qualification testing has started.  
(d) First instance of primary or secondary structure acceptance testing has started.  
(e) First instance of flight or flight-like software module or integration testing has started.  
(f) First delivery or checkout of GSE and/or facilities for Constellation Program use has started.
  - 13.2 **APPLICABLE DOCUMENTS:**  
CXP-02012: Methodology For Conduct of Project Constellation Hazard Analyses
  - 13.3 **CONTENTS:**

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The Constellation Program Office will specify and operate a centralized problem data system that will provide an electronic method of entering, managing and tracking software and hardware problem data related to all Constellation-related programs.

The system will be available to all authorized users in real-time for problem disposition/status and to all users in real-time for new issue submittal, data query, and report generation. The system will facilitate entry of data in the field, where appropriate, such as ground system personnel entering problem data at the point of inspection. Technologies such as radio frequency identification and/or bar-code marking may assist in easily identifying components and storing data. Full access to the problem data system shall be maintained from 48 hours before planned launch/use through completion of the mission or activity. PRACA-reportable problems will be documented in the Constellation Program problem data system using common data elements and codes as specified by the Constellation Program.

All problems associated with the Constellation Program shall be stored in the Constellation Program problem data system.

#### 1. Problem Reporting Requirements

##### 1.1 Reporting Criteria and Reportable Problem Definition

The organization that discovers any hardware or software problem on Constellation systems shall document them in the central Constellation problem data system. All nonconformances and anomalies shall be screened to determine whether they are reportable as PRACA problems. All Constellation-related nonconformances and anomalies initiated by any element provider or Constellation integrator shall be assigned to the responsible design element to be evaluated for PRACA reportability. Furthermore, an organization that discovers a nonconformance or anomaly in hardware/software that is used by multiple projects/programs (i.e., common component) shall enter the issue into the database and immediately inform other known users regarding the issue.

A PRACA-reportable problem shall be any nonconformance or anomaly on Constellation system flight or flight-like hardware, software, GSE, facilities, or tools that meets or is suspected of meeting at least one of the following criteria:

- (a) Hardware functional failures occurring or identified during testing, checkout, or use;
- (b) Flight-related software (FSW) nonconformance of Severity 1 or 2 post release for flight;
- (c) Any hardware or software failure that caused a launch or mission use delay beyond the scheduled/planned window;
- (d) Unsatisfactory condition;
- (e) Unexplained anomaly;
- (f) Overstress or potential overstress of hardware;
- (g) Any nonconformance that has been shown by trend analysis to need recurrence control;
- (h) An issue that calls into question the safety or flight-worthiness of previously accepted hardware/software;
- (i) Nonconformances on GSE that meet the design element's criteria for reportability, as defined in the design element's requirements, could cause serious injury or death of personnel, or could damage or compromise performance or support of flight hardware/software;
- (j) A nonconformance that is a first time or worst case manifestation of a failure mode or hazard cause;
- (k) Any occurrence of a Criticality 1/1R/1S or 2/2R failure mode;
- (l) Any nonconformance that invalidates certification, a CIL retention rationale, or a Hazard control, or results in an increase in risk categorization (as defined in CXP-02012, Methodology For Conduct of Project Constellation Hazard Analyses, Sections 6.3 and 6.4);

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- (m) Any quality escape;
- (n) Any impacted NASA ALERT;
- (o) Any problem recommended by the responsible design element/project;
- (p) Any in-flight anomaly (IFA), defined as an anomaly, nonconformance, or problem occurring or detected from continuous operation immediately preceding launch/use through termination of its mission use (including its on-orbit duty cycle) that meets one of the above criteria or at least one of the following:
  - 1. affected or could have affected crew safety;
  - 2. affected or could have affected vehicle integrity;
  - 3. affected or could have affected successful mission completion;
  - 4. caused or could have caused mission delay, scrub, abort, or early mission termination;
  - 5. caused violation of flight crew on-orbit scheduling or safety constraints.

To be a PRACA-reportable problem, it must occur or be detected during the period from design qualification testing through the hardware/software's life cycle, including:

- (a) Qualification/certification testing (excludes hardware modifications not currently certified).
- (b) Acceptance testing.
- (c) In-flight/on-orbit.
- (d) Turnaround operations including ground test, overhaul, and repair.
- (e) Shipping and receiving of flight or flight-like hardware delivered to the government.
- (f) When the nonconformance evaluation shows previously accepted/delivered flight or flight-like hardware requires a design change.

#### 1.2 Timing of Problem Notification

The organizations that detect nonconformances and anomalies shall be document them and enter them into the Constellation problem data system. If the problem is PRACA-reportable, it shall be identified as a PRACA-reportable problem within two working days of isolation to the Line Replaceable Unit (LRU) or software module. If the problem is not isolated to a specific LRU within seven calendar days of occurrence/detection, it shall be identified as PRACA-reportable in the Constellation Program problem data system. Reportable problems that occur from the Constellation Flight Readiness Review (FRR) through completion of the CEV's mission phase or during a flight/use which could potentially affect flight operations, ground crew safety, or mission success shall be reported to the CEV Project Office prior to use and no later than one working day from detection. If the problem is detected before the hardware or software is used, it shall be reported to the CEV Project Office prior to launch and /use. CEV Project Office managers shall be responsible for reporting significant problems to the Program Control Board (PCB) or mission support team (MST) to support launch, flight, or on-orbit use decisions.

#### 1.3 Problem Reporting Responsibilities

The CEV project, contractor, subcontractor, or vendor who has custody of the hardware or software when a nonconformance or anomaly occurs or is detected shall report it into the Constellation nonconformance and problem data system. The responsible organization shall review the nonconformances/ anomalies, flag PRACA reportable problems in the nonconformance and problem data system, and ensure that the reports are accurate and complete.

#### 1.4 Additional Requirements for In-Flight Anomaly (IFA) Reporting

The CEV Project Office shall identify each IFA, process each one as a PRACA-reportable problem, and report them to the Constellation flight

management organization. The IFAs shall normally be presented to the Constellation flight management organization no later than two days prior to the Constellation flight readiness review for the next flight/use or within fourteen working days of post-occurrence analysis, whichever comes first. For missions scheduled too close together to meet this requirement, the IFA report shall be presented at the prelaunch mission management team meeting for the upcoming flight. If post-processing evaluation or post-flight reconstruction is not completed in time for a full report to be support presented to the Constellation flight management organization, a report of IFA findings to date and an evaluation of the potential associated risk of proceeding without that data shall be presented. Additional IFAs shall be reported to the earliest meeting of the Constellation flight management organization or flight readiness review as they are identified.

## 2. Problem Disposition

Common processes for determination of problem root cause, assessment of risk, fault isolation techniques, problem resolution, implementation of remedial or corrective action, and verification of corrective action effectiveness shall be used throughout the Constellation Program. The responsible Design element Office shall evaluate all PRACA-reportable problems for potential program-wide implications. This ensures that the problem is isolated to a particular hardware/software component and that the potential constraints to program and project events, milestones, and use of the affected components are properly understood. The element provider shall disposition only those critical hardware/software nonconformances for which it has design responsibility and which directly apply to the upcoming mission (e.g., nonconformance on launch pad in use, MRB nonconformance on flight vehicle, etc.). Each of these shall receive interim disposition or shall be closed prior to flight.

### 2.1 Problem Cause Determination

Activities shall be taken to isolate each PRACA-reportable problem to a root cause. If this is not possible, a most probable cause shall be determined.

### 2.2 Problem Disposition Methods

Problems shall be dispositioned through:

- \* disposition by explanation (i.e., remedial action only but no additional corrective action required),
- \* closure by corrective action (design change, process change, equipment change, testing/ inspection change, revisions to training/instruction/certification, and/or limiting usage), or
- \* interim disposition for a specific time or hardware set(s) duration, complete with usage rationale. The interim disposition applies until the problem has been completely resolved and the duration of the interim disposition has been precisely defined.

### 2.3 Interim Disposition

Temporary disposition of problems for specific component sets or time frames not to exceed 6 months or 3 specific hardware/software units shall be permitted based on safety-of-flight/use rationale, to include at least one of the following:

- (a) The problem is not applicable to the flight(s)/use (i.e., system not installed and/or used on the flight).
- (b) The problem condition is clearly screened during preflight/pre-use checkout or special tests.
- (c) The problem is time/age/cycle related and the flight/test units will accumulate less than 50% of the critical parameter(s) by the end of the flight.
- (d) There is rationale that this is an isolated case and not a generic problem.
- (e) There is no application of the involved component/system on the



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flight/test unit where the experienced failure mode could result in a safety or mission critical failure ( i e., only Criticality 3 applications).

(f) The problem is applicable to the flight(s)/use (system is used during the mission); however, the Constellation Program formally approves that the system can be flown as an acceptable risk.

#### 2.4 Problem Disposition Authority

All PRACA reportable problem closures shall require NASA approval. Disposition of safety-critical failure mode problems, unexplained anomalies, and in-flight anomalies shall require approval of Safety and Mission Assurance and either the Constellation Program Manager or the Deputy Constellation Program Manager. Disposition approval of other PRACA-reportable problems may be delegated by the Constellation Program Manager.

#### 2.5 Documentation Requirements for Problem Disposition

PRACA-reportable problems shall be documented in the Constellation nonconformance and problem reporting and corrective action data system using the program-defined standard data fields and codes (to be defined in a database document TBD).

Required documentation for problem disposition shall be as follows:

- (a) Closed Problem - Documentation shall include the root cause(s), remedial and/or corrective action (if required) or rationale for no corrective action required. If the problem is dispositioned by explanation with no corrective action required, the consequences of the problem occurring in-service and possible work-around shall also be documented.
- (b) Unexplained Anomaly (problem root cause(s) cannot be determined) - Documentation shall include the probable cause(s), rationale for flight/use without a definitive cause, and recommended work-around if the problem recurs.
- (c) Interim Disposition - Documentation shall include the root cause (if known) or basis for deferral of cause determination, affectivity of the interim disposition, and the rationale for flight/use. (Reference Paragraph 2.3 for interim disposition criteria.)

If problem analyses reveal inaccuracies or omissions in the FMEA/CIL, human factors process FMEA, software fault analysis, or Hazard Analysis, the contractor responsible for continuing engineering support on the system shall update the involved document(s) to correct the deficiency.

#### 3. Trending

The Contractor shall periodically perform and report trend results and also on a timely, ad hoc basis in response to identified significant adverse trends. The Contractor shall use nonconformance/problem data, production parameters (such as Statistical Process Control), and performance data to identify hardware, software, and/or human interface processes that are not in control, need additional review, and/or require correction. The Contractor will also report trends based on failure recurrence, risk measure, and/or cost. This will include effectiveness/concerns resulting from use of standard repairs. Where possible, trend tracking technologies such as Integrated Vehicle Health Monitoring Trending shall be incorporated to proactively measure trends. Trending and/or data mining mechanisms/systems shall also to be employed to preemptively isolate impending failures/failure conditions and support recommendations for corrective actions to mitigate critical failures or reduce risk. As a minimum, the trending data shall show problem occurrence frequency by subsystem, by LRU, by failure mode, and by cause. Trend results shall be normalized into failure rates based on wear (as run time or starts) and/or opportunities for error detection (as inspections, tests, or units delivered). Trending results and related

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problem analyses shall be provided to the CEV Project on a regular basis (at least quarterly) and to the Constellation Program when significant results are determined.

## 4. Data Elements

## 4.1 Hardware PRACA Data Elements:

1. Report Number-Report number assigned by the design center, contractor, or KSC
2. IFA Number-Official in-flight anomaly number assigned by the Program
3. Mission Effectivity-Mission number, element code, and hardware effectivity
4. Project Element-CEV element
5. System-CEV-subsystem code
6. Date Detected-Date originally detected
7. Closed Date-Date the applicable design center or Project Office approved the problem resolution
8. Location-Site at which the problem was detected or occurred
9. Test/Operation-Test or activity at the time of problem detection
10. Detected During- document number and type describing this operation when problem was detected
11. Contractor-Contractor/manufacturer who built/supplied failed item/component
12. Problem Title
13. Problem Description-Description of the problem as first noted/up to date description of problem
14. Part Number/Nomenclature/Serial Number
15. Hardware Criticality-Categorization of the singular direct effect of the identified failure mode of a hardware item
16. Functional Criticality-Categorization of the effect of loss of redundancy for a given component or function in the discrepant condition
17. Part Criticality-Highest level criticality of the effected part
18. Cause-The event or series of event ultimately responsible for the problem
19. Related Documents/Related Document Type/Related Document number-Reference information to documents (waivers, ALERTS, etc.) associated with the identification or resolution of the problem
20. Out of family-Yes/No field designated whether problem is an out-of family occurrence
21. Responsible Organization or Person-Person or organization responsible for report
22. Disposition summary-The failure analysis and resolution of the problem and any action taken to correct the problem. This may include an interim disposition summary
23. Subsystem-CEV Element subsystem
24. Element location- Physical location on the CEV where the problem occurred
25. Prevailing Condition-Environment type when detected
26. FMEA number-FMEA number which addresses the failure mode of failed elements (to the lowest level possible)
27. Failure mode-A description of the manner in which an item failed
28. CIL Rationale-Yes/No indicator that tells whether a CIL is affected
29. Material Defect, A-Defect-Indicates the defect that resulted in the failure
30. Material Defect, B-Material-Indicates the material that failed
31. Recurrence Control Code-Classification of the primary recurrence control actions
32. End Item Control Number-An end-item control number is a sequential identifier contained in an implementing organization instructions
33. Date Isolated-Date that the problem was isolated
34. Date/Time updated-Date/time of latest status or update
35. Contractor Resolution-Date the contractor submitted the full problem resolution

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36. Expected date or mission of Interim disposition-Date that last interim disposition occurred
37. Latest Interim Disposition Date-Date that last interim disposition occurred
38. Process Escape-Classification of process escape
39. Problem status-Problem resolution status-Open, Closed, Explained, Deferred, Void, Not a Problem
40. Hazard Report Number-Number associated with the approved hazard report
41. Hazard Report Cause Identifier-Unique number of hazard report hazard cause
42. Operating time/Cycle-total operating time on the hardware when the problem occurred, may be number of cycles
43. Detection method-How the problem was initially detected
44. Time to repair-Time taken to complete repairs on the original failed unit (from problem detection, until full operation restored)
45. Level of Repair-Level of maintenance where the repair took place
46. Number of maintenance crew-number of persons required to perform the repair
47. Associated problem number(s)-PR, DR, MR number of problem before it was upgraded to a reportable problem

## 4 2 Software PRACA Data Elements

1. Discrepancy Report (DR) Number-six digit number identical to the number on the associated DR form
2. Origination Date-Date when the Software DR management form was written
3. Revision Date-Date when the latest revision to the DR management form was written
4. DR Title-title, the same as on the associated Software DR form
5. Process Escape-Classification of the process escape
6. Software Code-Severity Code, same as on the Software DR
7. Log Date-Date that the associated Software Dr was logged into the contractor problem reporting database.
8. Description of Problem-The number and type of system failures and the requisite operational scenario that caused the software condition to occur
10. How user see effects-Summarizes the effects of the associated discrepancy on the CEV and Constellation system and should explain how the external user should see these effects
11. Principal functions affected-All principal functions or functional areas to which the problem is believed to be applicable
12. Cross Reference-Program change requests (CRs), DRs, or CRs that are related to the problem
13. Disposition-Software DR Closure code for the associated discrepancy
14. Avionics and Software Control Board Release Code-Earliest currently supported released system against which the DR is applicable
15. Rationale for Disposition-Acceptability rationale for waivers and reasons behind the schedules for Software DR fixes
16. Contact-The responsible analyst and/or associated Software DR form author
17. Avionics and Software Board Responsible Engineer-Name of the responsible engineer
18. Author-Initiator of the original DR
19. Found by Organization-Organizational element where the associated DR was found
20. Phase fault/problem was inserted - When it can be determined, development phase during which the problem was inserted into the software (e.g. requirements, design, code)
21. Phase in which the problem was discovered and the method used to uncover the problem (e.g. Design/peer review, Implementation/unit testing)

- 22. Operational Workarounds - list any operational workarounds put in place while repairs are considered. Indicate if temporary or if workarounds become long term or permanent, should have way to trigger a review of the DR and record accordingly
- 23. Avionics and Software Control Board Date-Date that the latest revision to the DR management form was dispositioned
- 24. DR Class-Classification of the DR (routine, no fix, closure; waiver; waiver with future fix; fix ASAP-no waiver; requirements issue
- 25. Remarks-Used to capture additional information including problems identified as out-of-family occurrence
- 26. Hazard Report number-Approved hazard report number
- 27. Hazard Report Cause Identifier-Unique number of the hazard report hazard cause
- 28. IFA number-Official In-flight Anomaly number assigned by the project office

134 **FORMAT:** Electronic format per Section J-2 2.3.2.1

13.5 **MAINTENANCE:** Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-S-014
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/20/2005
5. **PAGE:** 1
6. **TITLE:** Quality Assurance (QA) Audit Report
7. **DESCRIPTION/USE:**  
The Contractor shall document the findings and results of internal and sub-contractor audits on processes, procedures, and operations performed by the contractor QA organization.
8. **DISTRIBUTION:** As determined by the Contracting Officer
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
The frequency of submissions shall be every 6 months after hardware fabrication starts and through all hardware development, testing, manufacturing, and assembly. A summary report of previous audits will be presented at the Critical Design Review (CDR).
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 3.4.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Quality Assurance (QA) Audit Report documents the findings from audits of processes and procedures, and operations which implement the quality program. Each audit shall include examination of all operations and documentation, comparison of actual operations to established requirements, requests for corrective and preventative action, identification of the root cause(s) of problems, and follow-up to verify that corrective actions are effectively implemented. Audit results in each area shall be documented in a report with requests for correction of deficiencies. The results shall be documented, maintained as records, and distributed to affected organizations.
- 13.2 **APPLICABLE DOCUMENTS:**  
CXP-02006: Constellation Program Quality Document (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)
- 13.3 **CONTENTS:**  
The Quality Assurance (QA) Audit Report shall include:
  - (a) Date performed.
  - (b) Process, procedure, or operation audited
  - (c) QA involvement.
  - (d) Evaluation/audit criteria.
  - (e) Findings, including detected problems, with reference to problem report(s) as appropriate.
  - (f) Recommended corrective action.
  - (g) Follow-up schedule for corrective action.
- 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

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- 13 5 MAINTENANCE: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

- |    |                     |    |                      |            |
|----|---------------------|----|----------------------|------------|
| 1  | <b>PROGRAM:</b> CEV | 2. | <b>DRD NO.:</b>      | CEV-S-015  |
| 3. | <b>DATA TYPE:</b> 1 | 4  | <b>DATE REVISED:</b> | 12/20/2005 |
|    |                     | 5  | <b>PAGE:</b>         | 1          |
- 6 **TITLE:** Critical Processes
7. **DESCRIPTION/USE:**  
The Contractor shall document the controls that they shall use for those manufacturing processes where uniform high quality cannot be ensured by inspection alone.
8. **DISTRIBUTION:** As determined by the Contracting Officer
- 9 **INITIAL SUBMISSION:** Preliminary Design Review
10. **SUBMISSION FREQUENCY:** Final by Critical Design Review, updates as required.
11. **REMARKS:**  
The Contractor shall document the controls that they will use for those manufacturing processes where uniform high quality cannot be ensured by inspection alone.  
The following document(s) may be used as guidance:  
• ANSI/ESD S20.20-1999: ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)  
• NASA-STD-8739.1: Workmanship Standard for Staking and Conformal Coating of Printed Wire Boards and Electrical Assemblies  
• NASA-STD-8739.2: Workmanship Standard for Surface Mount Technology  
• NASA-STD-8739.3: Soldered Electrical Connections  
• NASA-STD-8739.4: Crimping, Interconnecting Cables, Harnesses, and Wiring  
• NASA-STD-8739.5: Fiber Optic Terminations, Cable Assemblies, and Installation
- 12 **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 3.4.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Critical Processes captures the Contractors' controls for manufacturing processes where quality cannot be ensured by inspection of articles alone. These manufacturing processes include, but are not limited to, metallurgical, and chemical processes, metal joining processes, bonding processes, plastics application, plating and coating and surface treating. In addition, inspection processes such as radiography, ultra-sonics, liquid penetrant, and magnetic particle, shall be controlled to ensure that the results indicate the article or material actual quality levels.
- 13.2 **APPLICABLE DOCUMENTS:**  
IPC-2221: Generic Standard on Printed Board Design  
IPC-2222: Sectional Design Standard for Rigid Organic Printed Boards  
IPC-6011, Performance Class 3: Generic Performance Specification For Printed Wiring Boards  
IPC-6012: Qualification and Performance Specification for Rigid Printed Boards

13.3 **CONTENTS:**

The Critical Processes document shall include as a minimum:

1. Process controls:

(a) Applicable manufacturing processing requirements with detailed performance and control provisions.

(b) Process preparation requirements.

(c) Detailed processing operations.

(d) Conditions to be maintained during each phase of the process including environmental controls.

(e) Methods for verifying the adequacy of the processing materials, solutions, equipment, environments, and their associated control parameters.

(f) Required records for documenting the results of the process inspection, test, and verification.

2. Equipment certification:

(a) Manufacturing equipment tests and their results shall be recorded, certified, and maintained.

(b) Plans for recertifying equipment as required by quality surveys, inspections or tests, or when changes are made which may affect process integrity.

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE:** Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.



## DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-S-016
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/20/2005
5. **PAGE:** 1
6. **TITLE:** Mechanical Parts Management and Implementation Plan
7. **DESCRIPTION/USE:**

To define and document the contractor's requirements, system and implementation plan for controlling the selection, acquisition, traceability, testing, handling, packaging, storage and application of Mechanical Parts (including fasteners, bearings, studs, pins, rings, shims, valves, springs, brackets, clamps, and spacers) for flight and critical ground support equipment.
8. **DISTRIBUTION:** The contractors Mechanical Parts Control Plan shall be provided to NASA CEV S&MA Activity as a minimum for approval.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**

Draft submission by System Definition Review.  
Final submission due at TBD.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 3.4.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**

The Mechanical Parts Management and Implementation Plan defines contractor's approach to managing the selection, acquisition, traceability, testing, handling, packaging, storage, and application of mechanical parts.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**

The Contractor's Mechanical Parts Management and Implementation Plan shall include the following:

  1. **Parts Selection:** The Mechanical Parts Management and Implementation Plan shall describe a concurrent engineering process, integrated with hardware design, in which parts are selected for use on the basis of suitability for the intended application. The plan shall identify parts that are considered standard and how other (nonstandard) parts will be evaluated, approved as flight and controlled.
  2. **Controlling specifications:** Parts shall be controlled by specifications which delineate as a minimum:
    - (a) Complete identification of the part.
    - (b) Physical, environmental, and performance specifications.
    - (c) Reliability requirements, including inspections and tests for qualification, acceptance, and lot sampling.
    - (d) Special handling, packaging, and storage requirements.
    - (e) Documentation, data retention, and submittal requirements.

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## 3. Part Qualification:

- (a) Parts shall be qualified to the requirements of the controlling specification. Part qualification shall demonstrate that the part meets its ratings, and that the manufacturer is using materials, processes, design, and quality controls that will produce a consistent, reliable, high quality device that is deemed suitable for the intended application.
- (b) Where adequate qualification data are not available, the plan shall describe the process of qualification testing to demonstrate that the part meets its ratings.

4. Design Configuration Acceptability and Control: The plan shall address how the selected parts for a design are reviewed for application and environment suitability, how the parts quality and reliability will meet the operational performance requirements, and if the parts are being used within the specific device ratings. Key elements are as-designed-parts lists, application stress analyses, and nonstandard parts acceptability assessments.

5. Parts Procurement: The plan shall address the contractor's source inspections, receiving inspection (including destructive physical analysis), and stocking and handling procedures prior to and during assembly. These procedures shall address how the contractor will avoid the procurement and any subsequent installation of parts or 'lots' of parts subject to conditions identified in GIDEP and NASA ALERT's. This section of the plan shall ensure that the selection and use of the parts will not have an 'obsolescence' issue to the greatest extent possible.

6. Fastener Quality: (1) Verification methods to confirm that fasteners conform to the specifications to which they are represented to be manufactured, (2) Identification of accreditation of laboratories engaged in fastener testing; and (3) Documentation of inspection, testing and certification processes and procedures.

7. Commercial Off-The-Shelf (COTS) hardware: The plan shall address the use of COTS hardware for which insufficient parts information is available. In these cases, parts used in COTS hardware may be qualified by environmental and accelerated life testing of a complete COTS assembly.

13.4 **FORMAT:** Electronic format per section J-2 2 3.21

13.5 **MAINTENANCE:** Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

## DATA REQUIREMENTS DESCRIPTION (DRD)

- 1 PROGRAM: CEV 2. DRD NO.: CEV-S-017  
3. DATA TYPE: 1 4. DATE REVISED: 12/19/2005  
5. PAGE: 1  
6. TITLE: Workmanship Standards  
7. DESCRIPTION/USE:  
The Contractor shall document its workmanship standards/specifications to demonstrate that they meet or exceed the provided guidance documents. The Contractors' internal workmanship standards should be used to the maximum extent possible. Where contractors' specifications do not meet or exceed the guidance documents, justification must be provided prior to NASA approval of its use.  
8. DISTRIBUTION: As determined by the Contracting Officer  
9. INITIAL SUBMISSION: Preliminary Design Review  
10. SUBMISSION FREQUENCY: Final due at Critical Design Review, updates required if workmanship standards or designs change  
11. REMARKS:  
The Contractor should demonstrate and verify control of the quality of the operation by employing workmanship standards throughout all phases of hardware manufacture. The intent of this standard is to ensure that manufacturing quality requirements are defined and that designs permit and facilitate the quality considerations of producibility, repeatability, and refurbishability/maintainability.  
The following document(s) may be used as guidance:  
• ANSI/ESD S20.20-1999: ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)  
• NASA-STD-8739.1: Workmanship Standard for Staking and Conformal Coating of Printed Wire Boards and Electrical Assemblies  
• NASA-STD-8739.2: Workmanship Standard for Surface Mount Technology  
• NASA-STD-8739.3: Soldered Electrical Connections  
• NASA-STD-8739.4: Crimping, Interconnecting Cables, Harnesses, and Wiring  
• NASA-STD-8739.5: Fiber Optic Terminations, Cable Assemblies, and Installation  
12. INTERRELATIONSHIP: Parent SOW Paragraph(s): 3.4.  
13. DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
This document captures the Contractors' workmanship standards/specifications and ensures that the meet or exceed NASA and Project guidance documents. The Contractors' internal workmanship standards should be used to the maximum extent possible. Where Contractors' specifications do not meet or exceed the guidance documents, justification must be provided prior to NASA approval of its use.  
13.2 APPLICABLE DOCUMENTS:  
IPC-2221: Generic Standard on Printed Board Design  
IPC-2222: Sectional Design Standard for Rigid Organic Printed Boards  
IPC-6011, Performance Class 3: Generic Performance Specification For

Printed Wiring Boards  
IPC-6012: Qualification and Performance Specification for Rigid Printed Boards

133 **CONIENIS:**

The workmanship standards specification shall, as a minimum, comply or exceed, the guidance standards as listed in section 13.2 (or its NASA-accepted contractor equivalent) for the areas of:

- a. Soldering.
- b. Crimping.
- c. Wire Harnesses.
- d. Connectors.
- e. Printed Circuit Boards - layout and fabrication.
- f. Electro Static Discharge.
- g. Conformal Coating.
- h. Surface Mount Technology.
- i. Staking.
- j. Fiber Optics

134 **FORMAI:** Electronic format per Section J-2 2.3.2.1.

135 **MAINIENANCE:** Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

1 PROGRAM: CEV 2 DRD NO.: CEV-S-018  
3. DATA TYPE: 3 4. DATE REVISED: 12/20/2005  
5. PAGE: 1  
6. TITLE: Software Quality Assurance (SQA) Audit Report  
7 DESCRIPTION/USE:  
The Contractor shall document the findings and results of software process and product audits by the contractor SQA organization.  
8. DISTRIBUTION: As determined by the Contracting Officer  
9. INITIAL SUBMISSION: Per Data Requirements Matrix  
10. SUBMISSION FREQUENCY: Submission frequency is every six months after software development starts and through all software development and testing. A summary report of previous audits will be presented at the software requirements review (SWRR).  
11 REMARKS:  
A summary report of previous audits will be presented at the Software Requirements Review (SWRR). Software audits during operations and maintenance will concentrate on effects of changes to the software on the quality, safety, and reliability of that software as well as appropriate configuration management of changes.  
12. INTERRELATIONSHIP: Parent SOW Paragraph(s): 3.5.  
Related DRD(s): CEV-S-001  
13. DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
The purpose of an SQA audit is to assure that proper control procedures are being followed, that required documentation is maintained, and that the developer's status reports accurately reflect the status of the activity. The SQA product is an audit report to management consisting of findings and recommendations to bring the development into conformance with standards and/or procedures.  
Software Quality Assurance (SQA) Audit Report documents findings resulting from conducting audits of daily software development and test processes and product deliveries. Audits should be conducted with sufficient detail to allow evaluation of both the progress and effectiveness of both software engineering and assurance tasks and the need for adjustments or changes.  
13.2 APPLICABLE DOCUMENTS:  
NASA-STD-8739.8: NASA Software Assurance Standard (Chapter 6 and 7)  
13.3 CONTENTS:  
The Software Quality Assurance (SQA) Audit Report shall include:  
1. Date performed.  
2. List of SQA personnel involved in audit and number of hours spent on audit.  
3. Evaluation/audit criteria.  
(a) Which software process (management, technical, or assurance processes) or product is being reviewed?

- (b) Which established procedures and standards are they being compared to?
4. Findings, including detected problems, with reference to software problem report(s) as appropriate.
  5. Recommended corrective action.
  6. Date for follow-up corrective actions (if necessary).
  7. Status on any remaining corrective actions from previous audits.
- 13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.
- 13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-O-001
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/20/2005
5. **PAGE:** 1
6. **TITLE:** Contractor's CEV Concept of Operations
7. **DESCRIPTION/USE:**

This document describes the contractor-recommended life cycle operations concepts for the entire CEV System. This document is necessary to provide a mechanism for NASA to understand and assess the Contractor's CEV Concept of Operations (CONOPS) for integration with NASA's CEV concept of operations. It also provides an integration mechanism with the CEV design process to assure operational needs and attributes are appropriately implemented in the design. While the CONOPS does not represent explicit design-to requirements, it is expected that the CONOPS will be reflected in the allocated requirements baseline derived using the CONOPS as a source.
8. **DISTRIBUTION:** Per Contracting Officer's letter
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**

The following document(s) may be used as guidance:

  - ANSI/AIAA G043-1992: Guidance for Preparation of Operational Concept Documents
  - CXP-00004: Constellation Operations Concept Document
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 7.  
Referenced from SOW Paragraph(s): 9.2
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**

The Contractor's CEV Concept of Operations describes operations for the entire CEV System from delivery of the spacecraft to the launch site, through pre-launch processing, pre-mission flight design and planning, launch, flight, re-entry, landing, and disposal and/or refurbishment for a future flight. It addresses operations from the flight crew, ground operations, and flight operations perspectives. It is expected that the depth and breadth of information contained in the Contractor CEV CONOPS will increase over time and with subsequent deliveries.
- 13.2 **APPLICABLE DOCUMENTS:**

CXP-00002: Constellation Design Reference Missions (DRM)  
CXP-10001: Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD)
- 13.3 **CONTENTS:**

This plan consists of two volumes that cover the CEV Contractor plan and recommendations for CEV operations.

  - I. Contractor CEV Concept of Operations
  - II. CEV Contractor Support to Operations
  1. Volume I: Contractor CEV Concept of Operations

The Contractor CEV CONOPS shall provide guidance to the CEV System developers on how the CEV System is to be used, operated, and maintained in a given environment so that their designs, development, integration, and tests will accommodate CEV goals, missions, and operational philosophy. The document shall describe the contractor's concept of the 'what, where, when, who, why, and how' of CEV System operations from delivery to KSC through disposal of assets.

The Contractor CEV CONOPS shall address the following:

- (a) Description of operations concept. This includes scenarios from CEV spacecraft delivery to the launch site, through pre-launch processing, pre-mission flight design and planning, launch, flight, re-entry, landing, and disposal and/or refurbishment for a future flight.
- (b) Fundamental spacecraft capabilities.
- (c) Description of the operational environment.
- (d) Operations constraints due to spacecraft design.
- (e) Roles and Responsibilities of the Flight Crew, Ground Operations, and Flight Operations. Include description of automation.
- (f) Analysis of proposed system, analysis of alternatives, trades considered, limitations, and constraints.
- (g) Identify technologies and methodologies and provide the associated benefit (cost, schedule, or operational) for infusion into the flight and ground operations.
- (h) Nominal, off-nominal, and emergency operational scenarios in narrative and graphical form, and evidence that the Contractor's specifications of performance and design support the concept.
- (i) Comparison of the contractor implementation with respect to the CXP-00004, Constellation Operations Concept Document, CXP-00002, Constellation Design Reference Missions (DRM), and CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD) and provide the supporting rationale for any deviations.
- (j) Assess the CEV performance across all the DRMs in the CXP-00002, Constellation Design Reference Missions (DRM). Identify and provide supporting rationale for the CEV spacecraft limiting factors (e.g. systems' performance, consumables, etc.) for each DRM and across all the DRM's.
- (k) Description of CEV System integration with the Constellation flight and ground systems.

## 2. Volume II: CEV Contractor Support to Operations

This volume shall include the Contractor's:

- (a) Proposed organizational infrastructure, personnel and Contractor-provided equipment needed to support both the sustaining engineering effort and the continued safe operation of the CEV through the completion of its life cycle;
- (b) List of critical activities with supporting rationale requiring contractor support;
- (c) Approach for interactions with NASA operations;
- (d) Description of key activities and schedules for obtaining or updating licenses, plans, processes and procedures required to support this contract including the export control licenses and software licenses;
- (e) Description of proposed activities to continually improve operational processes throughout the CEV System life-cycle to decrease operations costs and improve efficiency and how the identified improvements will be incorporated into those operational processes.

13.4 **FORMAT:** The CONOPS shall be narrative and delivered in electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE:** Changes shall be incorporated by complete reissue.



## Crew Exploration Vehicle - (CEV)

## DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-O-002
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/20/2005
5. **PAGE:** 1
6. **TITLE:** Flight Hardware/Software Operations and Maintenance Requirements Development Plan and Requirements Document
7. **DESCRIPTION/USE:**  
To define the process for developing the operations and maintenance requirements, and the delivery of those requirements
8. **DISTRIBUTION:** Per Contracting Officer's letter
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 7.2.  
Referenced from SOW Paragraph(s): 9.4  
Related DRD(s): CEV-T-011
13. **DATA PREPARATION INFORMATION:**
- 13.1. **SCOPE:**  
The Flight Hardware/Software Operations and Maintenance Requirement Development Plan describes the Contractor's approach to develop requirements necessary for the development of safe and effective operational procedures.  
  
The Flight Hardware/Software Operations and Maintenance Requirements Document defines the requirements for the CEV ground operations.
- 13.2. **APPLICABLE DOCUMENTS:**
- 13.3. **CONTENTS:**  
The Flight Hardware/Software Operations and Maintenance Requirements Development Plan shall contain the Contractor's approach and processes for developing the operations and maintenance requirements.  
  
The Flight Hardware/Software Operations and Maintenance Requirements Document shall contain the requirements necessary to develop NASA ground processing, launch, and post-landing operations procedures for the CEV. Requirements shall include limited-life, time and cycle limits, expected operational limits (e.g., temperature, pressure, humidity, voltage, current, preventive maintenance), and storage requirements. Each requirement shall include technical rationale, derivation of operational limits and tolerances, and, if reusable, the fair wear and tear criteria.  
  
The Flight Hardware/Software Operations and Maintenance Requirements Development Plan and the Flight Hardware/Software Operations and Maintenance Requirements Document shall include detail at a level commensurate with the state of the system design at the time of document delivery.
- 13.4. **FORMAT:** Electronic format per Section J-2 2.3.2.1.

13 5 MAINTENANCE: Changes shall be incorporated by complete reissue..

**DATA REQUIREMENTS DESCRIPTION (DRD)**

- |   |                     |   |                      |            |
|---|---------------------|---|----------------------|------------|
| 1 | <b>PROGRAM:</b> CEV | 2 | <b>DRD NO.:</b>      | CEV-O-003  |
| 3 | <b>DATA TYPE:</b> 3 | 4 | <b>DATE REVISED:</b> | 12/20/2005 |
|   |                     | 5 | <b>PAGE:</b>         | 1          |
- 6 **TITLE:** Launch Site Support Requirements Documentation
- 7 **DESCRIPTION/USE:**  
This document shall be used to coordinate the identified resources to enable the hardware developer to complete the necessary work on the flight hardware. Support requirements include shared services and facilities provided by KSC and Cape Canaveral Air Force Station (CCAFS)
- 8 **DISTRIBUTION:** Per Contracting Officer's letter
- 9 **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10 **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11 **REMARKS:**
- 12 **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 7.2.
- 13 **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
Provides the launch site support requirements needed by the hardware developer for work to be done at either KSC or CCAFS.
- 13.2 **APPLICABLE DOCUMENTS:**  
KSC-HB-GP60-3: ASRS Handbook
- 13.3 **CONTENTS:**  
The Launch Site Support Requirements Documentation shall identify the operations resources (e.g., commodities, office space, special flight hardware access requirements, telephones, fax machines) required by the CEV Contractor to process the CEV System at KSC/CCAFS in accordance with KSC-HB-GP60-3, ASRS Handbook.  
  
The Launch Site Support Requirements Documentation shall identify the support requirements in a CEV Project requirements document (PRD) per the ASRS Handbook.
- 13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.
- 13.5 **MAINTENANCE:** Changes shall be incorporated by complete reissue.



## Crew Exploration Vehicle - (CEV)

## VII. CEV Flight Capability Envelopes

## VIII. CEV Ascent, Orbit, and Entry Structural Envelopes

The content to be included in each volume shall be coordinated with the NASA subsystem managers to ensure the CEV ODB contains the appropriate level of detailed information to meet the users' needs.

The specific content of each volume is:

## 1. Volume I: CEV Spacecraft Systems Performance and Constraints Data

## (a) Vehicle system configurations and coordinate systems.

This data shall include pictorial representations of the CEV showing coordinate systems, locations, axes, dimensions, separation planes, etc.

## (b) Constraints and operational limitations.

This data shall include CEV spacecraft operational hardware and software constraints and limitations and the corresponding result if a limit is exceeded or a constraint is violated.

(Constraints are defined as those methods of operation or procedures for operation imposed upon hardware components/systems, which if violated, may affect crew safety, result in performance degradation, or affect mission timelines. Limitations are defined as those measurable or detectable operational limits, which if exceeded, will affect crew safety or result in performance degradation.)

## (c) Operational performance and operational data.

This information shall include a supporting discussion for the CEV spacecraft constraints and operational limitations. It also contains descriptions of the fundamental performance of CEV spacecraft systems' and subsystems' components. Typically, fundamental data is used for Systems Analysis and for computer modeling and simulation. Consequently, data is defined at a basic level and the user is responsible for properly utilizing the data for evaluation purposes.

(This section typically includes CEV spacecraft system descriptions; functional block diagrams; subsystem block diagrams; subsystem characteristics; simplified logic control schematics; operational mode descriptions; safe mode operation; command processing; command memory dumps; fault detection, isolation, and recovery (FDIR) triggers; integrated vehicle health management (IVHM) information; system alerts; operational ranges of critical parameters; and mass, volume, and capacity properties for consumables and other storage).

## 2. Volume II: CEV Spacecraft Systems Electrical Equipment List

The Electrical Equipment List (EEL) shall describe the CEV spacecraft electrical equipment, its power usage, quality of the data, electrical bus identification, cooling code, circuit protection, panel switch or circuit breaker, procurement specification, and schematic drawing number and applicable notes. The content of this volume is divided into subsystems.

## 3. Volume III: CEV Mission Mass Properties Data

## (a) CEV Body Referenced Coordinate System Definition:

This section shall define the requirement for the coordinate system that describes the locations of the centers of mass of CEV system components, and the orientations of body referenced vectors. Examples of body referenced vectors include axes of symmetry, rotational axes, thrust vectors, lift vectors, sensor, instrument, and antenna pointing vectors,

window normal vectors, etc. The coordinate system has three orthogonal axes and an origin that are fixed with respect to the CEV structure. The definition shall include engineering drawings and mathematical descriptions of the coordinate system. The engineering drawings provide views along the positive and negative orthogonal axes, and several oblique views to give a clear intuitive understanding of the relationship between the vehicle structure and the coordinate system. The mathematical description shall include transformation matrices between the body referenced system and other coordinate systems that will be used with the CEV. Examples of coordinate systems requiring transformation matrices include body-fixed coordinate systems defined by the axes of instrument pointing hardware, the navigational base coordinate system, if different from the body-centered system, and geocentric, heliocentric, or selenocentric inertial and rotating coordinate systems that are used in flight dynamics computations.

(b) CEV Mass Properties Data:

This requirement shall provide the total mass, center of mass, and moments and products of inertia of the CEV in several standard configurations. It shall also contain the individual masses and centers of mass of CEV system components for which masses may vary. Mass and center of mass data shall be given for a vehicle with dry consumables tanks, full consumables tanks, and for vehicle configurations in which externally mounted appendages, such as antennas, booms, or solar arrays, are in both the stowed and deployed positions. The data shall also include the centers of mass of storage volume compartments, and of crew positions occupied during powered flight and atmospheric entry. The mass properties data shall include the algorithm used to calculate total vehicle mass and center of mass, given the values for individual vehicle components, consumables masses, crew and crew equipment masses, and stowed cargo mass. Moments of inertia about the three orthogonal body axes, and products of inertia, shall be provided for each vehicle configuration. Moments and products of inertia are required for attitude dynamics computations, such as executing attitude maneuvers, or establishing a stable rotational rate about a body axis.

4. Volume IV: CEV Spacecraft Systems Contingency Analysis Data

This volume of the CEV ODB shall contain data that supplements Volume I data. This volume shall expand upon the data documented in Volume I to include failure signatures and off-nominal CEV spacecraft systems and subsystem operations. It also includes constraints associated with systems and subsystems operation under the described conditions. The data presented is for use in contingency situations or when systems and subsystems are operating in an off-nominal manner. This data is not required to have been verified by test; it will be derived primarily from analyses. The input data for these analyses, may be based on assumptions made from estimates, extrapolations, or best engineering judgment.

5. Volume V: CEV Aerodynamic and Astrodynamic Performance and Constraints Data

This volume of the CEV ODB shall contain the authoritative source for aerodynamic and flight performance characteristics data for the CEV and shall provide the astrodynamic values and associated uncertainties of the constants and models used in trajectory prediction. The required information is detailed below:

(a) Aerodynamic data.

The document shall provide a database of aerodynamic constants,

parameters, and vehicle characteristics that are used for CEV atmospheric and orbital flight performance simulations, trajectory computations, vehicle development, and analyses. These data shall include a full technical description of CEV aerodynamic characteristics, including coefficients of lift and drag, cross sectional areas, and ballistic numbers for standard vehicle flight phases, configurations, and control modes. Configurations include nominal and contingency aerodynamic characteristics for atmospheric entry, on-orbit drag characteristics with and without booms, arrays, or antennas deployed, and aerodynamic characteristics following ascent aborts.

(b) Astrodynamic Constraints and Parameters

The document shall provide a database of astrodynamic constants and parameters that are used for CEV orbital and atmospheric flight performance simulations, trajectory computations, vehicle development, and analyses. These data shall include astrodynamic constants, and a full technical description of the reference ellipsoids, geopotential models, and gravitational perturbation models used for the Earth and the Moon. The data shall also include lunar and solar orbital perturbation models for vehicles in Earth orbit, and the seasonal atmospheres, solar flux models, and vehicle data used for modeling drag perturbations. The data shall include heliocentric-ecliptic orbital elements for the Earth, and geocentric-ecliptic and geocentric-equatorial orbital elements for the Moon at the J2000.0 standard epoch. The data shall include full technical descriptions, including transformation matrices, of the inertial and body-fixed rotating coordinate systems used in CEV astrodynamic computations.

6. Volume VI: CEV Crew Module Landing and Emergency Rescue Data

This volume shall be a source document of properly validated CEV Crew Module data to be used by qualified landing, splashdown, and rescue personnel for the development of training information. This document shall contain illustrations for training associated with the CEV Crew Module, including layouts of structures and systems of interest to landing, splashdown, and rescue personnel. This volume shall document hazards and safety precautions, flight crew apparel, seat restraints and emergency breathing systems; emergency egress and entry procedures, emergency powerdown procedures; and payload hazards. A condensed, quick reference version of the above information shall be provided in a separate section for use in the field.

This document shall not replace specific crash/rescue/firefighting training directives and instructions issued by NASA, military and civil agencies.

7. Volume VII: CEV Flight Capability Envelopes

(a) Center of Mass Envelopes:

The document shall provide center of mass envelope data for the CEV. The center of mass envelope is a three dimensional volume within which the vehicle's center of mass must be located to ensure dynamic stability and controllability. The center of mass envelope may have different boundaries in different flight phases. The boundaries of the center of mass envelope must be defined for powered flight guidance and control, coasting flight attitude control, atmospheric entry and landing guidance and control, and unguided ballistic entry. The boundaries of center of mass envelopes for nominal and contingency operations do not represent absolute stability and control limits, but include a margin of safety.

## Crew Exploration Vehicle -- (CEV)

## (b) Thermal Envelopes:

The document shall provide thermal envelope data for the CEV. Thermal envelopes define maximum peak temperatures, maximum heating rates, and lower temperature limits within which the vehicle may safely operate. Different thermal envelopes may apply to different parts of the vehicle and different flight phases. Thermal envelopes shall be defined for nominal ascent, entry following ascent abort, on-orbit operations, nominal entry, and contingency entry operations. Entry thermal envelopes shall be defined for entry from low Earth orbit, and direct entry from an inbound trans-lunar trajectory. All entry thermal envelopes shall include vehicle attitude limits (pitch, yaw, roll, bank) with respect to the velocity vector. On-orbit thermal limits shall include operational thermal envelopes for parts of the vehicle that may require attitude management for thermal control or conditioning. Thermal envelopes for nominal and contingency operations do not represent absolute thermal limits, but include a margin of safety.

## (c) Translational Delta-V Capabilities:

The document shall provide translational delta-V capabilities data for the CEV. The translational delta-V capabilities define how much change in orbital velocity is attainable using the fully loaded CEV propulsion system. Delta-V capability is a function of vehicle mass, propellant load, specific impulse (Isp) of the propulsion system, and the gravitational acceleration of the central body. Capabilities shall be defined for operations in Low Earth Orbit (LEO), trans-lunar space, and lunar orbit. Delta-V capability must equal the greatest total mission delta-V required of the vehicle plus a margin of safety. The nominal performance envelopes (thrusts - maximum and minimum if throttle-able, maximum burn times, etc.) for orbital maneuvering engines shall be documented in Volume I, CEV Spacecraft Systems Performance and Constraints Data.

## (d) Attitude Control System Delta-V Capabilities:

The document shall provide attitude control system delta-V capabilities data for the CEV if propulsive attitude control systems are used. The attitude control delta-V capabilities define how much change in velocity is available for establishing and nulling out attitude rates about the vehicle body axes. Data shall include minimum and maximum attitude rates attainable. Minimum attitude rates are a function of the thrust of attitude control system thrusters and vehicle moments of inertia. Maximum attitude rates may be limits imposed by flight software or attitude control thruster burn time limits. Attitude control system delta-V capabilities should also include the possible thruster combinations used for attitude maneuvers about body axes, and those that could be used to augment the translational delta-V capability. Delta-V capability for attitude control must equal the maximum mission requirement plus a margin of safety. Attitude control thruster performance envelopes (thrusts, maximum burn times, etc.) shall be documented in Volume I, CEV Spacecraft Systems Performance and Constraints Data.

## (e) Launch Abort System (LAS) Operational Envelope and Capabilities:

The document shall provide Launch Abort System Operational envelope data for the CEV. The operational envelope of the LAS shall define when in the ascent trajectory it may be used, from the launch pad through jettison, and the velocity at which it must be jettisoned during a nominal ascent. The documented LAS capabilities shall include the expected accelerations and the family of trajectories that the LAS/CEV would follow, assuming LAS activation at different points during ascent. The data shall also describe the relative motion versus time between the LAS and the CEV after the LAS separates from the CEV following an ascent abort.



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## (f) Entry Corridor Definition Criteria:

The document shall provide entry corridor definition criteria for the CEV. The entry corridor definition criteria provide guidance for computing the minimum and maximum entry flight path angle limits, with and without dispersions, which permit safe entry into the Earth's atmosphere and precision landing. The entry corridor depends on the atmospheric density profile, and vehicle speed, mass, and aerodynamic characteristics. Therefore, entry corridors are computed on a flight-specific basis. Entry from LEO and entry from an inbound trans-lunar trajectory require different entry corridors. The shallow boundary of an entry corridor is the minimum entry flight path angle required to prevent an unwanted reversal in the sign of altitude rate from negative to positive. This could result in a large downrange error for landing, or even atmospheric skip-out. The steep boundary of the entry corridor is the maximum entry flight path angle that can be flown without violating thermal or structural load limits, or acceleration limits for the crew. Entry corridor definitions shall be documented for typical entries from LEO, and trans-lunar entries using standard seasonal atmospheres. Entry corridors shall be documented with and without atmospheric dispersions, uncertainties in navigation accuracy, vehicle center of mass, and aerodynamic characteristics.

## (g) Entry Guidance Limits:

The document shall provide entry guidance limits for the CEV. Entry guidance limits define the maximum entry trajectory dispersions that the guidance and control systems can successfully correct, while ensuring that the vehicle remains within structural, thermal, and acceleration limits during entry, and achieves its trajectory targets at the end of the entry guidance phase. Entry guidance limits also include the acceptable tolerances for each target parameter at the end of the entry guidance phase. Entry guidance targets could include latitude, longitude, altitude, altitude rate, heading, drag acceleration, dynamic pressure, and other parameters plus their associated tolerances at the end of the entry guidance phase. The specific entry guidance limits and entry guidance targets depend on the entry guidance algorithms chosen for the vehicle, and vehicle design.

## (h) Entry Cross Range Limits:

The document shall provide entry cross range limits for the CEV. Cross range limits are the maximum distances to the right or the left of the ground track, at which the CEV is capable of touching down. Cross range is measured perpendicular to a tangent to the ground track. Cross range capability is a function of vehicle aerodynamic characteristics, vehicle control capabilities, and the geometry of approach to the landing site. Cross range limits are used in planning deorbit and landing opportunities.

## (i) Landing Footprint Accuracy:

The document shall provide landing footprint accuracy data for the CEV. Landing footprint accuracy defines the downrange and cross range dimensions of landing ellipses about the targeted touchdown coordinates for various levels of uncertainty in onboard navigation accuracy, onboard guidance and control capability, and environmental dispersions. Landing footprint accuracy will help to define the required landing site characteristics for touchdown on land.

## (j) Sensed Acceleration Limits:

The document shall provide sensed acceleration limits for the CEV. Onboard rate gyros and accelerometers sense translational and rotational vehicle accelerations and incorporate this information into onboard navigation. The minimum detectable translational accelerations and rotational rates, and their associated uncertainties, must be specified.

8. Volume VIII: CEV Ascent, Orbit, and Entry Structural Envelopes

(a) CEV Longitudinal and Lateral Load/Acceleration Limits:

The document shall provide load/acceleration limits for the CEV. The longitudinal and lateral structural load limits define the maximum positive and negative accelerations that the CEV structure can withstand along longitudinal and lateral body axes, and maintain structural integrity. For ascent, these limits should take into account the loads expected during nominal ascent, vehicle staging, loads resulting from Launch Escape Tower activation on the launch pad, and at all points in the ascent trajectory up to LET jettison, and loads expected during entry and touchdown following ascent aborts.

For the orbit phase, limits include the maximum acceptable structural load limit for the docking mechanism, and the minimum force required (if any) for the docking mechanism to work. This will help to define the acceptable range of relative rates for docking with other vehicles. On-orbit load limits should also specify the maximum longitudinal and lateral accelerations allowable for deployed appendages, such as antennas, booms, and solar arrays. These structural limits are relevant to the design of deploy mechanisms and on-orbit maneuver planning to prevent damaging deployed structures because of accelerations caused by maneuvers.

For entry and landing, these limits should take into account accelerations expected during entry along the steep boundary of the nominal entry corridor, and also for an unguided ballistic entry if that is an acceptable entry downmode option. Mach number, dynamic pressure, and acceleration limits for the deployment of parachutes or other drag inducing systems, and touchdown on land and water are also required. Touchdown acceleration limits will factor into the design of parachutes or other drag inducing systems.

(b) Lateral Motion Limits for CEV Touchdown on Land and on Water:

The document shall provide lateral motion limits for CEV touchdown. Lateral motion limits define how fast the CEV may be moving horizontally at touchdown on land or water, without violating structural integrity, tumbling, or harming the crew. If the vehicle lands within lateral motion limits, it should remain upright and intact, and not violate crew acceleration limits. Surface winds, the capabilities of landing systems, vehicle center of mass and coefficient of friction, and the characteristics of landing surfaces all factor into these limits. These limits influence landing system design and landing site requirements.

(c) CEV Dynamic Pressure Limits:

The document shall provide dynamic pressure limits for the CEV. Dynamic pressure limits specify the maximum force per unit area that the CEV structure can withstand without violating structural integrity, or overstressing points of connection between separate vehicle elements, during ascent and entry. Dynamic pressure is a function of the atmosphere and the vehicle's trajectory.

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE:** Changes will be incorporated by electronic revision with change tracking.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-O-005
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Flight Operations Procedures Data
7. **DESCRIPTION/USE:**  
This document contains the CEV Contractor inputs to spacecraft procedures. This document will be used by the NASA-led flight operations team to develop the initial CEV spacecraft procedures.
8. **DISTRIBUTION:** Per Contracting Officer's letter
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 7.3.1.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The procedures inputs shall include nominal operations, including in-space assembly, the activation and checkout of systems, deactivation of systems, steady-state operations, and in-flight maintenance; and nominal and off-nominal time-critical actions. The content includes input for all crew and mission control center based executable procedures affecting onboard systems and functions.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The CEV Flight Operations Procedures Data document shall include the following:
  1. CEV Procedure Data Inputs - Detailed, step-by-step procedure inputs for all CEV spacecraft flight operations.
    - (a) The procedure data inputs shall cover nominal operations, including in-space assembly, the activation and checkout of systems, deactivation of systems, steady-state operations, and in-flight maintenance; and nominal and off-nominal time-critical actions.
    - (b) The procedure data inputs shall include the data for both the flight crew and the mission control center-based executable procedures affecting on board CEV systems and functions.
    - (c) The procedure data inputs shall reflect integration across the flight software, vehicle hardware, and available telemetry.
    - (d) Where required, the procedure data inputs shall include initial condition verification steps used prior to action steps.
    - (e) Where required, the procedure data inputs shall include status verification step(s) necessary to verify that an action or series of actions were successfully accomplished.
  2. Associated supporting documentation for the procedures, including:
    - (a) Task description, frequency, and estimated completion time.
    - (b) Rationale for each step in each procedure and source of that information.

- (c) Information on the source of all parameter numeric values used in procedures.
- (d) Execution notes, such as equipment needed, information required to perform a task, etc.
- (e) Initial conditions and final conditions.
- (f) Operational constraints (i.e. limitations on how, in what sequence with other actions, or when the task may be performed.)

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-O-006
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/20/2005
5. **PAGE:** 1
6. **TITLE:** CEV Stowage Capabilities and Services Handbook
7. **DESCRIPTION/USE:**  
The CEV Stowage Capabilities and Services Handbook provides the procedures, development process/product flows, dependencies, capabilities and constraints, and required planning and operations information used in developing generic and flight specific stowage products for each CEV mission.
8. **DISTRIBUTION:** Per Contracting Officer's letter
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 7.3 1
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The CEV Stowage Capabilities and Services Handbook will be used by equipment providers, spacecraft loading and unloading personnel, manifest planners, and flight controllers to ensure that equipment is properly stowed and that all operational requirements are being met during planning and operations.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The CEV Stowage Capabilities and Services Handbook shall provide the procedures, development process/product flows, dependencies, and required planning and operations information used in developing stowage products and services.  
  
The CEV Stowage Capabilities and Services Handbook shall include, but is not limited to, the functional areas of:
  1. Stowage Operations Documentation. This document shall include information covering the following areas as a minimum:
    - (a) Overview of CEV Stowage Capabilities.
    - (b) Layout and schematics of Stowage Locations and Volumes.
    - (c) Physical Dimensions.
    - (d) Mechanical Dimensions and interfaces.
    - (e) Available Services (e.g., power, cooling, and thermal controls and constraints, etc.).
    - (f) Environmental Conditions (e.g., humidity/environmental, pre-launch atmospheric controls and constraints, electromagnetic interference (EMI), etc.).
    - (g) Operational Restrictions and Rationale (e.g., center of gravity and real-time operations and handling constraints, temporary stowage restrictions/constraints, etc.).
    - (h) Procedures and Rationale (e.g., procedures to access or open stowage

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compartments, unfasten restraints, connect to vehicle services, power up and power down, stowage compartment and content labeling system, etc ).

(i) Requirements for Stowed Equipment (including pre-launch, on-orbit, temporary stowage, landing and post landing timeframes).

(j) Operations safety processes and documentation to provide stowage safety compliance evaluation.

(k) Schedule and process (e.g., schedule/process for late load into vehicle pre-launch, for delivery of hardware for packing, labeling and to support pre-launch loading).

13.4 **FORMAT**: Delivered in electronic format per Section J-2 2.3.2.1

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

## DATA REQUIREMENTS DESCRIPTION (DRD)

1 PROGRAM: CEV 2 DRD NO.: CEV-O-007  
3 DATA TYPE: 1 4 DATE REVISED: 12/20/2005  
5 PAGE: 1  
6 TITLE: Range Safety Requirements Documents  
7 DESCRIPTION/USE:  
Provide Range Safety Requirements Documents that are tailored from AFSPCMAN 91-710, Range Safety User Requirements Manual, and NPR 8715.5, Range Safety Program, with supporting rationale of the changes, as applicable, to meet CEV/CLV processing, launch, reentry, and landing configurations. Range Safety Requirements Documents will also be required for NASA operations at other Government-owned test ranges.  
8 DISTRIBUTION: Per Contracting Officer's letter  
9 INITIAL SUBMISSION: Per Data Requirements Matrix  
10 SUBMISSION FREQUENCY: Per Data Requirements Matrix  
11 REMARKS:  
NASA will obtain Range approval of the tailored Range Safety Requirements Documents.  
12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 7.4.  
Referenced from SOW Paragraph(s): 3.2  
13 DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
The tailored Range Safety Requirements Documents will address AFSPCMAN 91-710 and NPR 8715.5 requirements separately using two major combinations of CEV/CLV:  
1. Unmanned CEV/CLV  
2. Manned CEV/CLV  
For flight tests conducted at other Government owned test ranges, the Range Safety Requirements Documents shall include analyses consistent with Range Commanders Council - Range Safety Group - Standard 321-02, COMMON RISK CRITERIA FOR NATIONAL TEST RANGES  
13.2 APPLICABLE DOCUMENTS:  
AFSPCMAN 91-710: Range Safety User Requirements Manual  
NPR 8715.5: Range Safety Program  
Range Commanders Council - Range Safety Group - Standard 321-02: COMMON RISK CRITERIA FOR NATIONAL TEST RANGES  
13.3 CONTENTS:  
1. The tailored Range Safety Requirements (AFSPCMAN 91-710) Documents shall address the original requirements/processes, recommended revision, change rationale in each of the following areas:  
(a) AFSPCMAN 91-710 Volume 2 'Flight Safety Requirements'  
(b) AFSPCMAN 91-710 Volume 3 'Launch Vehicle, Payloads, and Ground Support Systems Requirements'  
(c) AFSPCMAN 91-710 Volume 4 'Airborne Flight Safety System Design, Test, and Documentation Requirements'  
2. The analyses for Flight Tests conducted at other Government owned test

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ranges shall address Range Commanders Council - Range Safety Group - Standard 321-02, COMMON RISK CRITERIA FOR NATIONAL TEST RANGES to ensure compliance with a common set of debris protection policies, risk criteria, and guidelines to protect personnel and assets during manned and unmanned flight operations. It establishes the following:

- (a) Maximum risk criteria for both the general public (involuntary acceptance) and mission essential personnel (voluntary acceptance)
- (b) Debris lethality criteria for unprotected and sheltered personnel
- (c) Debris damage thresholds for aircraft and ships

3. The analysis for orbital and reentry debris shall be in accordance with NPR 8715.5 paragraph 3.4.6 Debris Risk Assessment.

- 13.4 **FORMAT:** Format shall follow documented processes and procedures in AFSPCMAN 91-710 and Range Commanders Council - Range Safety Group - Standard 321-02. Electronic format per Section J-2 2.3.2.1.

- 13.5 **MAINTENANCE:** Changes shall be incorporated by complete reissue



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## DATA REQUIREMENTS DESCRIPTION (DRD)

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-O-008
3. **DATA TYPE:** 2/3\*
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Ground Systems Requirements, Plans, Reports and Design Data
7. **DESCRIPTION/USE:**

Volume I: Define CEV requirements for NASA-provided facilities, facility systems, NASA and Contractor-provided support equipment and associated software to support flight and ground operations.  
Volume II: Deliver plans and design data for CEV Contractor-provided support equipment end items to support flight and ground operations.  
Volume III: Deliver an operations and maintenance plan and requirements for Contractor-provided support equipment necessary for CEV ground and flight operations  
Volume IV: Deliver a sustaining engineering plan for Contractor-provided support equipment necessary for CEV ground and flight operations.
8. **DISTRIBUTION:** Per Contracting Officer's letter
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**

\* Plan submitted at SDR will be Data Type 2. Reports will be Data Type 3.

As part of the Quarterly PMR, the ground system project report addresses design, acquisition, build/modification and certification activities of CEV Contractor-provided support equipment including schedules, procedures, progress to date, expenditures, and cost forecast.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 9.1.  
Referenced from SOW Paragraph(s): 9.2, 9.4  
Related DRD(s): CEV-T-005, CEV-T-029, CEV-T-031, CEV-T-035, CEV-T-048, CEV-T-087
13. **DATA PREPARATION INFORMATION:**
- 13.1. **SCOPE:**

Provide design and development details of CEV Contractor-provided ground systems, the CEV design requirements for Government-provided ground systems, and operations and maintenance requirements for Contractor-provided GSE.
- 13.2. **APPLICABLE DOCUMENTS:**

NASA-STD-5005B: NASA Standard for Ground Support Equipment (and associated Applicable Document Children as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)
- 13.3. **CONTENTS:**

CEV Ground Systems Requirements, Plans, Reports and Design Data shall consist of four volumes, each providing the Contractor's requirements, plan or approach to a different aspect of ground systems.

  - I. Ground Systems End Item Requirements Document and Report
  - II. Ground Systems End Item Implementation Plan and Report
  - III. Ground Systems Operations and Maintenance Plan and Requirements

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## Documentation

## IV. Ground Systems Sustaining Engineering Plan

The volumes are to include detail at the level commensurate with the state of the design at the time of document delivery.

1 Volume I: Ground Systems End Item Requirements Document and Report  
The document shall define the requirements for facilities, facility systems, support equipment and associated software. This volume shall flowdown the requirements from the Ground Support Equipment SRD (DRD CEV-T-031) and the Software Requirements Specification (DRD CEV-T-048) for GSE.

Requirements for facilities and facility systems shall include:

- (a) Narrative description of the purpose and/or function of the facility, room, system, and/or equipment item.
- (b) Physical dimensions of the item(s) or area including any required lifting weight, center of gravity, and ceiling hook height.
- (c) Number and skill of personnel assigned to a facility or area by discipline (e.g., managers, engineers, accountants, secretaries, and administrative personnel requiring office space; technicians, mechanics, inspectors, requiring break rooms and lab space).
- (d) Hazard identification (e.g., classification of hazards, type of propellants, types of vents, types of purges, maximum fuel/oxidizer propellant quantities, types of ordinance, power voltages and frequencies, noise levels, RF radiation levels).
- (e) Environmental requirements (e.g., temperature, humidity, particle counts, radio frequency shielding, noise attenuation, etc.).
- (f) Power, grounding and lighting, including the use of uninterruptible power systems and supplies for ground operations activities.
- (g) Plumbing/venting and commodities for ground operations activities.
- (h) Fire and hazard protection.
- (i) Communications, data networking systems.
- (j) Special structural needs (e.g., vibration controls, floor loading, etc.).
- (k) Security (e.g., facilities, facility systems, personnel, hardware, software, badging, and access control).
- (l) Material handling requirements (e.g., crane or hoist requirements).
- (m) Environmental pollution controls.
- (n) Backup power and other backup or contingency requirements (chilled water, hot water, etc.).
- (o) Internal IRD (DRD CEV-T-035) for all interfaces with flight hardware, NASA and Contractor-provided ground support equipment, facility systems, and facilities.
- (p) References to any special studies and analyses that influenced the requirements.
- (q) Consideration of human engineering requirements.
- (r) Special operational requirements.

Requirements for support equipment and associated software shall include:

- (a) Narrative description of the purpose and/or function of the support equipment item.
- (b) Physical dimensions of the item(s) including any required lifting weight, center of gravity, and ceiling hook height.
- (c) Number and skill of personnel assigned to operate the Contractor-provided support equipment.
- (d) Hazard identification (e.g., classification of hazards, type of propellants, types of vents, types of purges, maximum fuel/oxidizer propellant quantities, types of ordinance, power voltages and frequencies, noise levels, RF radiation levels).
- (e) Environmental requirements (e.g., temperature, humidity, particle counts, radio frequency shielding, noise attenuation, etc.).

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- (f) Power, grounding and lighting, including the use of uninterruptible power systems and supplies for ground operations activities.
- (g) Communications, data networking systems.
- (h) Special structural needs (e.g., vibration controls, etc.).
- (i) Material handling requirements.
- (j) Environmental pollution controls.
- (k) Backup power and other backup or contingency requirements.
- (l) Storage requirements.
- (m) Internal IRD (DRD CEV-T-035) for all interfaces with flight hardware and support equipment.
- (n) Internal IRD (DRD CEV-T-035) for all interfaces with facilities and support equipment.
- (o) References to any special studies and analyses that influenced the requirements.
- (p) Consideration of human engineering requirements.
- (q) Special operational requirements.

The volume shall identify and include the Contractor's researched innovative technologies and methodologies for infusion into ground systems to improve safety, efficiency and life cycle costs.

The quarterly ground system project report addresses requirements development activities of CEV Contractor-provided ground systems including schedules, procedures, progress to date, expenditures, and cost forecast.

APPLICABLE DOCUMENTS for Volume I:

NASA-STD-5005: NASA Standard for Ground Support Equipment (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)

2. Volume II: Ground Systems End Item Implementation Plan and Report For Contractor-provided support equipment and associated software, the implementation plan provides the detailed hardware and software implementation approach and preliminary designs. This volume shall be in accordance with the ground systems requirements defined in the Volume I of this document.

The following elements are included as appropriate:

- (a) Provide descriptions, approaches, and preliminary designs with the intent to satisfy each of the requirements End Item Specification per DRD CEV-O-008, Volume I.
- (b) Environmental assessments, hazards abatements, analyses, and impact statements, as required.
- (c) Proposed site locations for activation and operational use.
- (d) Support equipment projected cost analyses
- (e) Project design, acquisition and build/modification approaches, concepts, and schedules
- (f) ICD (DRD CEV-T-029) for all interfaces with flight hardware and support equipment.
- (g) Proposed initial spares to be purchased for each support equipment item.
- (h) Plans to maintain and reconfigure these ground systems to be consistent with each configuration unique to the hardware/software characteristics of the test or flight.
- (i) Plans for the manufacture, assembly, inspection, test, calibration, certification and acceptance of ground system end items.

The quarterly ground system project report addresses design, acquisition, build/modification and certification activities of CEV Contractor-provided ground systems including schedules, procedures, progress to date, expenditures, and cost forecast.

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The volume shall identify and include the Contractor's researched innovative technologies and methodologies for infusion into ground systems to improve safety, efficiency and life cycle costs.

## APPLICABLE DOCUMENTS for Volume II:

NASA-STD-5005: NASA Standard for Ground Support Equipment (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List)

## 3. Volume III: Ground Systems Operations and Maintenance Plan and Requirements Document

For Contractor-provided support equipment and associated software, this volume shall include:

- (a) Plans and requirements necessary for safe and effective operation and maintenance, including calibration and validation intervals, for ground systems that support ground and flight operations.
- (b) Plans and requirements for required maintenance intervals, techniques and implementation
- (c) Preventive and predictive technologies used, including the equipment and labs required
- (d) Plans and requirements for systems and equipment required to perform maintenance

## 4 Volume IV: Ground Systems Sustaining Engineering Plan

For Contractor-provided support equipment and associated software, this volume shall include:

- (a) Planning for engineering support for problem resolution including Material Review Board (MRB) items
- (b) The approach for engineering review and analysis of proposed upgrades and modifications
- (c) The approach for maintenance and updates of all system documentation
- (d) The approach for reviewing all FMEA-CIL and hazard analysis identified critical items for mitigation or elimination.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Changes shall be incorporated by complete reissue.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

- 1     **PROGRAM:** CEV
- 2     **DRD NO.:** CEV-S-001
- 3     **DATA TYPE:** 1
- 4     **DATE REVISED:** 12/20/2005
- 5     **PAGE:** 1
- 6     **TITLE:** Safety and Mission Assurance (S&MA) Plan
- 7     **DESCRIPTION/USE:**

The Contractor shall identify and define the Contractor's plans and planned method of accomplishing the Safety and Mission Assurance (S&MA) tasks required by the Statement of Work (SOW) and meeting CEV System requirements. Since effective S&MA is heavily process driven, this document is the agreement between Contractor and the Government for how the Contractor plans to levy and implement safety and mission assurance upon the project.

The Contractor's Safety and Mission Assurance Plan shall include the following functions:

  - (a) design and development of controls; development of contingency and pre-mishap plans for major system tests, launches, and flights;
  - (b) electrical, electronic and electromechanical (EEE) parts;
  - (c) mechanical parts; emergency preparedness; fabrication controls;
  - (d) flight test/ground operations; handling and shipping for flight hardware and software;
  - (e) human error management;
  - (f) identification and data retrieval;
  - (g) maintainability; mishap and close call reporting, recording and investigation;
  - (h) metrology;
  - (i) nonconforming articles and materials;
  - (j) probabilistic risk assessment;
  - (k) procurement;
  - (l) quality assurance;
  - (m) reliability;
  - (n) risk management;
  - (o) safety;
  - (p) sampling plans/statistical planning and analysis;
  - (q) software assurance; software engineering;
  - (r) software formal inspection;
  - (s) software independent verification and validation documentation;
  - (t) stamp controls;
  - (u) supportability;
  - (v) systems engineering;
  - (w) testing/inspection/evaluations; and
  - (x) range safety.
- 8     **DISTRIBUTION:** As determined by the Contracting Officer
- 9     **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10    **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11    **REMARKS:**

Initial submittal of the document shall be one package; however, the Government may approve the volumes separately. The plan shall be organized by the major functions of S&MA organization, with a volume for each of the following disciplines:

  - (a) System Safety,
  - (b) Industrial, Environmental and Range Safety,

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(c) Reliability, Maintainability, and Supportability (RMS),  
 (d) Quality Assurance, and  
 (e) Software Assurance,  
 as described in the 'Contents' section of this DRD.  
 The Contractor shall continually update the Industrial, Environmental,  
 and Range safety volume of the S&MA plan when necessary, and submit for  
 NASA approval.

The following document(s) may be used as guidance:

- KHB 1700.7: Space Shuttle Payload Ground Safety Handbook

- 12 **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 3.  
 Referenced from SOW Paragraph(s): 3.2, 3.3, 3.4, 3.5  
 Related DRD(s): CEV-M-005, CEV-S-002, CEV-S-003, CEV-S-004, CEV-S-009,  
 CEV-S-010, CEV-S-011, CEV-S-018, CEV-T-005, CEV-T-006, CEV-T-019, CEV-T-  
 021

13 **DATA PREPARATION INFORMATION:**13.1 **SCOPE:**

The Contractor S&MA Plan shall address the Contractor S&MA philosophy,  
 organization, approach, and key processes to meet various program and  
 mission requirements. The plan shall be organized by the major functions  
 of an S&MA organization with a separate volume for each discipline area.  
 This permits each volume to be revised and approved individually (i.e.,  
 System Safety, Industrial, Environmental and Range Safety, Reliability,  
 Maintainability, and Supportability (RMS), Quality Assurance, and  
 Software Assurance). The plan shall provide process details of  
 integrating S&MA products, tasks, and results with design and systems  
 engineering processes to optimize the safety and mission success of the  
 CEV System.

13.2 **APPLICABLE DOCUMENTS:**

CXP-02006: Constellation Program Quality Document (and associated  
 Children documents as specified in Attachment J-3, Applicable, Guidance,  
 and Informational Documents List)  
 NASA-STD-8739.8: NASA Software Assurance Standard (Chapter 6 and 7)  
 S0300-BT-PRO-010: Government-Industry Data Exchange Program (GIDEP)  
 Operations Manual

13.3 **CONTENTS:**

The Safety and Mission Assurance Plan shall meet the requirements of the  
 applicable documents in 13.2 and consists of separate volumes for each  
 S&MA discipline. The plan shall describe the approach, including  
 groundrules and assumptions, for the development and review of S&MA  
 processes and products to be applied by the Contractor and its  
 subcontractors.

## Chapter 1, S&amp;MA Program Overview

The S&MA Overview shall contain a description of each of the other  
 volumes to serve as a reference. This shall include a description of the  
 overall Contractor S&MA organization including organization charts,  
 roles, and responsibilities. Other information that shall be included:

1. Define how the Contractor will establish and implement unimpeded  
 access and authority between S&MA, Systems Engineering, Design  
 Engineering and the Project Management levels with full project  
 responsibility.
2. Identify the process, techniques, databases, and sources that the  
 Contractor will use to identify program/project risks and mitigations  
 (risks that impact safety and mission success, and their mitigations).  
 Explain how the Contractor intends to identify program/project risks and  
 mitigations (risks that impact safety and mission success, and their

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mitigations)

3. Concurrent Engineering - Document how the Contractor will implement product requirements through the use of S&MA standards and processes that assure system safety, reliability, maintainability, supportability and quality (including for worst case environments for all mission phases) by effectively and efficiently designing-in the key attributes as part of the design effort. Provide details on how risks due to common cause failures shall be analyzed and eliminated by design to the extent possible, and how the balance of the residual risks shall be controlled.

4. Document how the Contractor S&MA organization will contribute to the overall planning, directing, and controlling of the integration, verification, activation, operation, and disposal activities including support to logistics, life cycle costs, maintenance, facilities, support equipment, personnel and training.

5. Provide details of the process the Contractor S&MA function will use to evaluate and approve design changes and then upon their approval, update Failure Modes and Effects Analysis, Hazard Analysis, and Risk Assessments during this process.

6. Provide details on how the Contractor S&MA organization will drive the selection and quality of the components and other materials to optimize reliability and mission success, with respect to the 'Materials and Processes Selection, Implementation, and Control Plan', DRD CEV-T-019.

For software, provide details on how the Contractor S&MA function drives the selection of Consumer-Off-the-Shelf (COTS), Government -Off-the-Shelf (GOTS), and reuse/legacy software as well as how this software will be verified and validated, and optimum safety, reliability, and mission success will be assured.

7. Provide a description of the methods (including Human Reliability Assessment) that will be used by the Contractor S&MA function to analyze and manage human error in the system design, operations, and ground processing activities.

8. Provide details on how the Contractor S&MA function is involved in the design certification process to ensure a robust design of systems.

## Chapter 2, System Safety Plan

The plan shall describe the Contractor's and subcontractors approach for the development and review of safety-critical products. This plan shall include:

1. A description of the Contractor's system safety tasks to be performed during all lifecycle phases.

2. A description of the processes that will be used to perform these system safety tasks, control the effort, accomplish the safety objectives, and verify compliance with the Constellation Program safety requirements, standards, and processes.

3. A Contractor Software Safety Plan, defining the method(s) to determine the activities and tools necessary to perform software safety activities for the CEV System lifecycle. These activities shall include:

(a) Software safety's function in system safety analyses, including the PHA, SHA, SSHA, and software safety analyses.

(b) Software safety's function in the change control board process.

(c) Method for clearly identifying and managing all software safety requirements. Software safety requirements shall identify the modes or states of operation which are safety critical and identify the 'must work' and 'must not work' functions during those applicable modes or states.

(d) Method for mapping the the relationship between all software safety

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requirements and system hazards.

(e) Method for evaluating the software production process to identify and eliminate or control real and potential process problems which could introduce failures, including latent failures, into flight and flight support software.

(f) Method for evaluating all acquired software products to ensure that they meet the Constellation Program safety requirements.

(g) Method for tracing the flow down of software safety requirements to design, implementation, and test.

(h) Method for identifying all software safety-critical design elements.

(i) Method for evaluating all software safety-critical code.

(j) Method for ensuring that safety-critical software test plans, procedures, and results are clearly identified and implemented.

(k) Method for reviewing and incorporating changes to safety-critical software requirements, design, implementation, and test plans/procedures.

(l) Method for ensuring risks affecting software safety are captured, addressed, and managed as part of project and facility risk management processes.

4. Identification of the safety output that will result from the expected application of the effort, with provisions for documentation of specific results of the safety effort. This shall include a description of how the Contractor S&MA group will work with Contractor engineering and management to ensure that system safety products will be used to increase the overall safety of the system.

5. Schedule of the Contractor safety activities, including milestone identification, program activities, program phasing, integration, and product delivery including the phased Safety Review hazard analyses and final safety certification.

6. Implementation of a project safety review process, and support to the NASA CEV Safety Review process.

7. A description of the processes and methods the Contractor will use to achieve compliance with safety requirements for integration of System Safety across Constellation elements. The plan shall document how the Contractor plans to verify and validate key systems safety requirements (loss of crew, minimization of potential human errors, failure tolerance criteria, etc.).

8. The methods the Contractor plans to use for hazard identification, control and tracking.

### Chapter 3, Industrial, Environmental, and Range Safety (IE&RS)

The Contractor IE&RS Plan shall contain sections related to Industrial Safety (such as OSHA requirements), Environmental (such as EPA requirements), and Range Safety. The plan shall define the methodology and techniques for achieving the project safety requirements. This shall include a description of how the Contractor IE&RS programs are conducted to meet requirements of the SOW and design specifications. The plan includes a definition of the Contractor's organization(s), the manager(s), and key personnel. Contractor points of contact and interfaces with other organizations having responsibility for safety of product are to be identified. The plan shall ensure that recognized hazardous conditions that may affect contract performance or progress are identified and resolved before operations begin, over the life of the CEV System.

1. The Contractor IE&RS plan shall include:

(a) A description of the Contractor IE&RS related tasks performed during



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the preliminary phase, system definition, design, manufacture, test, or operations that will be continued throughout the life of the system.

(b) An assessment and report the Industrial and Environmental safety impacts, the reliability and quality assurance of the flight test operations and integration facilities.

(c) A description of the methods that will be used by the Contractor to perform and audit these tasks, control the effort, accomplish the objectives, and verify compliance with requirements.

(d) Scheduling the Contractor safety effort, including milestone identification, program activities, program phasing, integration, and product delivery.

(e) Contractor Support and planning for the CEV System safety review process and NASA Facility and Range safety processes.

(f) How the Contractor will provide information and technical data required for NASA or its agent to complete its NEPA analysis, including but not limited to data concerning management processes, existing environmental permits, physical and environmental descriptions, and waste streams.

2. The industrial safety section in the Contractor IE&RS Plan shall include:

(a) Contractor Management commitment and employee involvement in the safety and health program:

- \* A statement of contractor management policy, commitment, and accountability to provide for the safety and health of personnel (i.e., employees, customers, and public) and property and compliance with OSHA (or State OSH) and NASA requirements.

- \* A provision for top-level Contractor management monthly safety and health committee meetings.

- \* Descriptions of Contractor safety and health awareness and motivation programs, including documented safety meeting requirements, and documented safety and health awareness training for employees.

- \* Means of Contractor program evaluation, identifying duties, methods and frequency for internal evaluation of the safety and health program, and identification of personnel who perform evaluations and to whom evaluations are reported and who approves corrective action.

- \* A flowdown of Contractor safety responsibilities between appropriate tiers (i.e., subcontractors).

- \* Identification of Contractor employees (by type, classification, and qualification) responsible for the implementation of the above elements.

(b) Contractor system and worksite hazard analysis:

- \* Methods of hazard identification and control, e.g., hazard analysis and risk assessment.

- \* Descriptions of OSHA (or State OSH) programs that require documented plans [e.g., Personnel Protective Equipment (PPE), Confined Space, and Lockout/Tagout, etc.]. Note: Only programs applicable to the contract need to be addressed.

- \* Requirements for formal safety inspections and correction of deficiencies.

- \* Requirements for documented safety visits.

- \* Schedules of the frequency and documentation requirements for inspections, plan and procedure reviews, and certifications

(c) Hazard prevention and control:

- \* Methods to include clear statements of hazardous situations and necessary cautions in appropriate detail plans, procedures, and other working documents.

- \* Contractor Controls of the procurement, storage, issuance, and use of hazardous substances.

- \* Method of ensuring a documented Contractor emergency management program.

- \* Contractor Plan for fulfilling the requirements of DRD CEV-S-004 Mishap Plan and Safety Statistics.

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- \* Provisions for Contractor safety and health services such as hazardous waste disposal, emergency medical support, personnel exposure monitoring and hazard communication.

- \* Provision for suspending Contractor work where safety conditions warrant such action.

(d) Safety and health training:

- \* Means for training each Contractor employee to recognize hazards and avoid accidents, and ensuring each employee has a clear understanding of the disciplinary program.

- \* Provisions for training and certification of Contractor personnel performing potentially hazardous operations. Job categories under the contracted effort that require certification shall be identified.

- \* Provisions for Contractor training to assist managers/supervisors and employees in their specific roles and responsibilities in safety programs

#### Chapter 4, Reliability, Maintainability, and Supportability (RMS) Plan

Provide full details of Contractor RMS organization, plans, processes, modeling and analysis to meet CEV System requirements and mission needs. Key Performance Parameters [KPP] for each of the Contractor RMS attributes shall be identified, designed in, and tracked from the start of the conceptual design stage and its progressive improvement throughout the life cycle of the system.

1. Provide details of the Contractor organizational structure of RMS with reference to other organizations such as Design Engineering, Systems Engineering and others, including interactions and interfaces with those disciplines
2. Provide a list and details of Contractor RMS tasks, processes, analyses, and verification and validation of results/progress for each key milestone of the program with a roadmap to meet the operational RMS and safety requirements of development and flight system.
3. Provide details of how Contractor RMS is integrated into the design function to improve system/subsystem reliability by influencing the design as part of the systems engineering model and design engineering processes.
4. Identify groundrules and baseline design assumptions, and planned Contractor RMS tools, including those for probabilistic design analysis (PDA) and structural reliability. Identify data assumptions, attributes of the model (including level, assumed relationships, etc.), timelines modeled, and capabilities modeled (i.e., crew escape). Identify the method to be utilized in verification of the models and provide the Government with access to this material.
5. Define the scope, content, approach, ground rules and assumptions that the Contractor will utilize in the development and performance of Probabilistic Risk Assessments (PRAs) and reliability predictions and allocations for the CEV System. The plan shall address the methods to be utilized along with any specific modifications to these methods. It shall also address data sources and model/data validation. The plan shall address the schedule and method for Bayesian updating. The plan shall address the method for maintaining systems engineering models that are compatible with the risk model developed as part of the probabilistic risk assessment to estimate and allocate component, subsystem, and human reliability values throughout the development and operation of the system.
6. Provide details of how the Contractor intends to perform and document

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a systematic review and evaluation of all Contractor RMS aspects of hardware design, development, manufacture, operation.

7. Provide details on how the Contractor will perform and document analyses, concurrent with the design effort, to determine the maintenance concept and resulting scheduled preventative and recurring maintenance requirements necessary to maintain CEV System safety and reliability.

8. Provide roadmap of reliability growth, i.e., how the Contractor will develop and implement reliability improvements on avionics boxes, subsystems, and systems, to achieve reliability goals. The section can utilize references to internal contractor/vendor procedures, processes and controls including EEE parts selection and control, material selection and controls, data sources, studies, etc., provided the Government has access to this material.

9. Provide process details and tools planned for effective Contractor integration of closed looped problem reporting, analyzing and corrective action system and nonconformance reporting and tracking system. Provide details of Contractor planned Problem Trending System to assess risk and provide input to reliability and maintainability analyses.

10. Provide process details of compliance to verification details of key Contractor RMS tasks. This should include verification and validation of design qualification and certification testing to meet the mission profile with due consideration for worst case environments. Applicable NASA Verification and Validation requirements shall be complied with to ensure a robust design while meeting program and mission success criteria and requirements.

11. Provide process details on how the Contractor intends to perform and document Contractor internal audits and vendor/supplier surveys to evaluate the progress and effectiveness of Contractor RMS activities and effectiveness of corrective action systems/processes and to determine the need for adjustments or changes.

12. Provide process details on how the Contractor intends to perform analyses to identify and determine limited life items age life, operating life, and shelf life and which items should be listed on the Limited Life Items List.

13. Provide process details on how the Contractor intends to assure the Limited Life Items are replaced and/or refurbished

14. Document how Contractor R&M design and operational performance requirements (qualitative and quantitative) will be established, documented, and implemented.

15. Document how CEV system maintenance concepts will be established, documented and implemented.

16. Document how Contractor R&M engineering, analysis, and testing requirements and tasks are established, documented and implemented.

17. Document how Contractor R&M Processes, analytical activities and data are integrated with systems engineering, risk management, and other processes, assessments and analyses.

18. Document how Contractor R&M activities are integrated with the associated design and operational functions and associated program/project safety, quality assurance, risk management, and logistics activities.

19. Document how a Contractor maintenance concept will be established and how compatibility is sustained among system design, maintenance planning, and logistics support activities.

20. Document how a Contractor data collection system to support R&M performance evaluation throughout the system's life cycle will be established and maintained.

21. Identify the organizations that will maintain the Contractor R&M data for the lifetime of the system.

22. Document how Contractor R&M is implemented as part of the design.

23. Document the approach to identify the CEV System operations and maintenance cost drivers.

24. Document the approach to establish and maintain a CEV System logistics support capability to sustain delivered hardware and software systems.

#### Chapter 5, Quality Assurance Plan

The Contractor Quality Assurance Plan shall identify, as applicable, the specific quality activities (implementation) related to the design and development, procurement of materials/subcomponents, fabrication, test, shipping, flight operations, refurbishment, and reuse to ensure the quality of the items delivered. The plan shall reference the Contractor's quality manual and procedures as necessary to fully describe the Contractor's quality system. (See the Software Assurance Plan, Chapter 6 for Contractor Software assurance requirements.) The plan shall include the following:

1. An identification of each Contractor Quality task to be accomplished under the Contractor QA Program (e.g. subcontractor monitoring, allocations process, etc.), a detailed description of how each quality task will be performed or complied with, and, the procedures (where existing procedures are applicable) to evaluate the status and control of each task.

2. Each quality element of CXP-20006, Constellation Program Quality Document (and associated Children documents as specified in Attachment J-3, Applicable, Guidance, and Informational Documents List), shall be addressed to describe the philosophy and approach for Contractor implementation. This may be satisfied by reference in the Contractor's quality plan to the Contractor's existing quality manual, provided a copy of the manual is delivered with the Contractor quality plan and the associated procedures are available for review.

3. Describe how the Contractor will involve NASA or NASA's representatives in reviews and approval of Contractor quality procedures and show compliance with the Quality Management System utilized at government facilities.

4. As a minimum, the subparagraphs below must be addressed by the Contractor quality plan and details of responsibilities and controls must be included to adequately describe the specific Contractor quality assurance activities related to hardware being procured by the CEV Project:

(a) Customer quality requirements- Include Contractor hardware specific quality requirements imposed by contract or component/equipment specification (i.e., traceability requirements, specific inspection

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- points, specific quality activities).
- (b) Responsibilities-Describe which Contractor organizations will perform the applicable quality activities below.
- (c) Uniform Quality - Define how the Contractor intends to develop, document, and implement controls for those processes where uniform, high quality cannot be assured by inspection of articles alone.
- (d) Article, Material, and Service Controls- Describe the level of article, material, and service control including traceability requirements invoked by the Contractor for the articles, materials, and/or services used in or performed as part of the hardware design and maintenance criteria, including how quality is ensured for each material, part, assembly, and/or service performed.
- (e) Procurement - Include the Contractor procurement quality requirements for all materials/parts/components the Contractor purchases and the level of control exercised over the suppliers (how are suppliers approved and monitored, how are supplier nonconformances monitored, etc.)
- (f) Milestone Reviews - Describe how the Contractor's quality system will support milestone reviews.
- (g) Configuration Assurance - Describe how the configuration of the CEV System hardware build is compared and verified to the approved design baseline drawings and specifications. Describe how the configuration of Government Furnished Property/Equipment is maintained.
- (h) Special Process Controls - Describe special process controls implemented for in-house processes and, if applicable, for subtier supplier processes.
- (i) Contamination Control - Develop, document and implement a Contractor contamination control plan to ensure that contaminant sensitive items are cleaned and controlled in accordance with documented procedures to the levels specified in the applicable technical documents and are maintained to these cleanliness levels.
- (j) Inspection and Test (describe who performs what inspections where) Include how the quality of purchased items are validated at receiving inspection or at subtier suppliers facilities, specific in-process (manufacturing) inspections performed, details of final inspection, functional and environmental test monitoring details, and pre-ship inspections. When applicable, provisions will be included for development of site quality plans for major end item test and flight test. Develop required inspections, inspection tools, and frequency of inspections, calibrations, and associated training for on-orbit activities as well as for manufacturing and assembly activities.
- (k) Nonconformance Reporting - Define how the Contractor intends to prepare and implement a nonconformance recording system to document all nonconformances starting with initial receipt of materials or articles and continuing through all subsequent phases of the program. Investigation processes and procedures, describing how root causes are identified with high degree of fidelity shall be included.
- (l) Nonconforming Product (Material Review Board (MRB) Process) - Describe the process of convening a nonconforming product material review board to disposition nonconforming product using a defined board of qualified personnel including contractor quality assurance personnel and customer representatives. MRB limitations within the Statement of Work (SOW) and membership qualification shall be defined. An MRB membership listing shall be submitted within the quality plan or by contract letter.
- (m) Flight Operations, Refurbishment, and Reuse - When applicable, describe how the Contractor's quality assurance system will be implemented for flight operations, refurbishment and reuse.
- (n) Record retention - For those Contractor records not delivered to the CEV Project, specify which records are required to be kept, who keeps them, for how long, and how they are to be dispositioned at the end of the retention period.
- (o) Define the Contractor's Sampling and Process procedures.
- (p) Define how the Contractor intends to develop, document and implement

the controls for handling, storage, preservation, marking, labeling, packaging, and shipping operations.

(q) Define how the Contractor intends to Participate in GIDEP in accordance with CEV DRD-S-012, Government-Industry Data Exchange Program and NASA Advisories/ALERTS, and SO300-BT-PRO-010, Government-Industry Data Exchange Program (GIDEP) Policies and Procedures Manual.

(r) Define how the Contractor intends to develop an Acceptance Data Package for all delivered hardware and software.

(s) Indicate how the Contractor production, installation and servicing processes will be controlled to ensure specific requirements are met. As a minimum the Contractor QA plan shall include all of the following:

- \* processes, procedures, and specifications
- \* The Process steps
- \* Methods to be used to monitor and control processes and product characteristics
- \* Acceptability criteria for workmanship
- \* Use of qualified processes, associated equipment and personnel
- \* Tools, techniques and methods to be used to achieve specified requirements

(t) Support to Contractor fabrication operations, including assembly, to ensure that characteristic and design criteria specified in technical documents are obtained and maintained in all supplier fabricated articles. Contractor Fabrication documents shall include or refer to:

- \* Nomenclature and identification of the article to be fabricated
- \* Tooling, jigs, fixtures, and other fabrication equipment to be utilized

\* Tools techniques and methods to be used to achieve specified requirements

- \* Characteristics and tolerances to be obtained
- \* Detailed procedures for controlling processes and cleaning, preservation, and packaging operations

\* Special conditions to be maintained such as environmental controls, specific cleanliness levels, and precautions to be observed

- \* Workmanship Standards
- \* Inspection and test operations to be performed during fabrication
- \* Special handling equipment and protective devices

(u) Contractor Controls employed to ensure that only conforming articles and materials are released and used and those not required for the operation involved are removed from the work area

(v) Develop and implement a Contractor Contamination Control and Foreign Object Debris document which will consist of an index of the methods and procedures used to implement the contamination control and foreign object debris prevention and control requirements. These methods and procedures shall cover end-item hardware, equipment, personnel, and control of such areas as fabrication, assembly, inspection, and test. The cleanliness level of contamination sensitive components and assemblies beginning with acceptance at the supplier level and continuing until customer acceptance shall be referred to in this document.

(w) Document and implement controls for those Contractor processes where uniform, high quality can not be assured by inspection of article alone, including but not limited to metallurgical and chemical processes, metal joining processes, bonding processes, plastics application, plating and coating processes, and surface treating processes.

(x) Document how Contractor personnel are trained and certified for processes and NDE; how techniques and processes have been certified; how Contractor facilities, equipment and materials for process control and NDE have been installed and how their use and maintenance are controlled; how resulting documentation, feedback, and records are controlled; document how NDE coordination with the cognizant engineering function as been implemented and how it will be documented on the drawings; and that Contractor personnel training and process certification procedures have been documented and accepted.

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- (y) Describe the Contractor's integrated approach to NDE, including organizational assignments, facilities, standards, and procedures.
- (z) Maintain an up-to-date listing of all Contractor process control procedures and process specifications used in fabrication, control, and inspection of the materials and articles fabricated.
- (aa) Document the Contractor's plan to control and monitor articles on the vehicle which are to be installed and removed, including shipping and handling protective materials. Document how temporary installations and removals shall be recorded for each vehicle from the first temporary installation through the life of the vehicle.
- (bb) Develop Contractor quality planning and procedural controls to support horizontal and vertical flight tests and associated ground operations to include as a minimum:
- \* Compatibility with planning and procedural controls
  - \* Define all Contractor quality activities relating to flight test/ground operations such as checkout, servicing maintenance, and refurbishment
- (cc) Develop and document specific Contractor inspection procedures and nondestructive evaluation techniques to be used during safing, transport, etc.; list the inspection and test procedures, test specifications, and processes for NDE techniques for maintenance and ground operations; define special equipment (NDE) needed to perform major inspections
- (dd) Develop a Contractor internal and sub-contractor audit program of processes, procedures, and operations which implement the Contractor quality program. The audits shall include examination of all operations and documentation, evaluation of actual operations as compared with established requirements, requests for corrective and preventative action, identification of root causes, and follow-up to verify effective implementation. Include audit schedules and reporting procedures.
- (ee) Document integration of the Contractor inspection methods used throughout all phases. Document an inspection flow that is in consonance with the manufacturing, processing, and test flow with significant inspection stations being identified. Allow for use of alternative techniques to support manufacturing, processing, and test operations. Ensure that the results of the tests and inspections is documented and can substantiate their accomplishment.
- (ff) For Contractor Inspections and tests, document how articles and materials will be controlled; inspection, test environments and equipment will be controlled; and the criteria for re-inspection and retest.
- (gg) Document how unusual phenomena, occurrences, difficulties or questionable conditions will be documented for Contractor end-items intended for delivery.
- (hh) Document how Contractor adjustments, modifications, repairs, replacements, or rework after completion of end-item inspections and tests shall be documented and approved by the customer.
- (ii) Document conditions that require functional tests or inspections to be performed on components prior to installation into the next higher assembly.
- (jj) Document Contractor Quality Assurance Actions prior to testing, during testing, and subsequent to testing.
- (kk) Document the Contractor controls established to ensure the integrity of hardware and materials.
- (ll) Document the Contractor control system to be used for inspection, measuring and test equipment specifically intended for use with CEV hardware.
- (mm) Document specific Contractor requirements and methods for the identification of the inspection and test status of products, documents and data, including stamp and electronic stamp control techniques, the use of electronic acceptance authority
- (nn) Document how nonconforming products are identified and controlled to prevent misuse until proper disposal.
- (oo) Document how records and data of all Contractor inspections and

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tests performed will be generated and maintained.

(pp) Document how the Contractor quality activity will review and administer controls for procedures and instructions of the controls for handling, storage, preservation, marking, labeling, packaging, packing, and shipping operations.

(qq) Document how the Contractor quality activity shall verify that manufacturing planning documents (routing sheets, operations sheets, travelers, etc.) contain handling instructions and the identification of any special handling equipment are used to prevent damage.

(rr) Document the Contractor plan and controls for control storage areas

(ss) Document how Contractor preservation instructions, including material and process definition are verified and are accomplished as contained in the manufacturing documents

(tt) Document how Contractor packaging operations are specified in the manufacturing documents, including sufficient detail to ensure the integrity of the packaging and the hardware, and that internal environments necessary to prevent degradation of the article or material are included in the packaging.

(uu) Document how appropriate Contractor marking and labeling for packaging, storage, and shipping of articles and materials is ensured and performed in accordance with applicable specifications.

(vv) Document how Contractor records specific to the product or project are to be controlled.

(ww) Document how training required for Contractor personnel performing a CEV System process will be identified and documented

(xx) Document required Contractor quality training activities (such as Excellence of workmanship and personnel skills, careful and safe operations, and maintenance and improvement of article and material quality) from development, maintenance and through to implementation

(yy) Document how Contractor personnel controlling critical processes and personnel performing critical operations shall be certified and how evidence of certification will be presented and maintained.

(zz) Document where specific statistical techniques are required and how they will be implemented

(aaa) Document the Contractor process control plan (how production, installation, and servicing processes will be controlled to ensure that specified requirements are met.

(bbb) Document the duties, responsibilities, and authorities of the assigned Contractor quality assurance personnel

(ccc) Document the Contractor system which identifies hardware/software characteristics requiring verification

(ddd) Document how quality characteristics and design criteria necessary for procurement, fabrication, inspection and test operations, and post flight operations are included in Contractor specifications, procedures, drawings, fabrication and planning documents.

#### Chapter 6, Software Assurance Plan

The Contractor Software Assurance Plan (SAP) shall plan, document and implement a software assurance program for software development, operation, and maintenance activities. This plan shall define the software assurance procedures, processes, tools, techniques, and methods to be used. The plan shall include details of procedures, reviews, and audits. The Contractor SAP shall include as a minimum:

1. Identify the Contractor SQA project's organizational structure, tasks, roles and responsibilities, and estimated resources.
2. Identify which Contractor software documents are to be reviewed or audited for adequacy. For each document listed, identify the reviews or audits to be conducted and the criteria by which adequacy is to be



confirmed.

3. Identify how software standards (documentation, design, coding, commentary, testing, metrics) will be monitored and assured by Contractor SQA.
4. Identify Contractor SQAs role in all software, project, product, and process reviews and audits. SQA software product and process audits shall be completed against the products and processes identified in DRD CEV-T-005, Software Development Plan.
5. Identify Contractor SQAs role in problem correction and corrective action.
6. Identify the software tools, techniques, and methods used to support Contractor SQA processes. State the intended use, applicability, or circumstances under which it is to be used or not to be used, and limitations.
7. Identify Contractor SQAs role in the audit of the configuration management products and processes and software delivery processes and products. SQA software configuration management audits shall be completed against the products and processes identified in DRD CEV-T-006, Software Configuration Management Plan.
8. Identify Contractor SQAs role in assuring that the software, provided by suppliers, meets established requirements.
9. Identify the Contractor SQA documentation to be retained, secured, and the length of retention.
10. Identify Contractor SQAs role in identifying, assessing, monitoring, and controlling all software risks.
11. An identification of each software assurance task to be accomplished under the Contractor SA program per NASA-STD-8739.8, Chapters 6 and 7. This shall include all SA disciplines: software quality assurance, software safety, software reliability, software verification and validation and independent verification and validation.
12. A detailed description of how each Contractor SQA task will be performed or complied with.
13. The Contractor procedures (where existing procedures are applicable, utilize them, where no existing procedures are applicable, develop new procedures) to evaluate the status and control of each task.
14. A detailed description of how the Contractor shall interface and support the NASA IV&V Facility as well as NASA Software Assurance in their required oversight and insight activities.
15. Describe how the Contractor will perform software assurance activities for requirements, design, coding, test, and the operation of software, including assuring that requirements-to-design and requirements-to-code checks are performed, assuring that program code complies with specified conventions and standards, and assuring that software tests were independently witnessed and discrepancies and/or anomalies are reported to project management and to an independent quality and safety organization.
16. Describe how the Contractor will audit its own and its supplier's internal software assurance activities with sufficient detail to allow

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evaluation of both the progress and effectiveness of software assurance tasks and the need for adjustments or changes

17. Describe how the Contractor will evaluate the software production process to identify and eliminate or control real and potential process problems.

18. Describe how the Contractor will implement control of processes, procedures, software, and equipment, configuration control and acceptance of flight and flight support software and documentation in accordance with requirements, standards, and procedures.

19. Describe the necessary Contractor training and certification needed to perform software assurance tasks.

#### Chapter 7, Critical Safety Item (CSI) Plan

The Contractor shall submit a Critical Safety Item (CSI) Plan that describes Contractor actions for the life cycle management of CSI. A CSI is defined as "a part, an assembly, installation equipment, launch equipment, ground support equipment, recovery equipment, or support equipment for an aircraft, launch vehicle, or space vehicle if the part, equipment, or assembly contains a characteristic whose failure, malfunction, or absence could cause a catastrophic or critical failure resulting in the loss of or serious damage to the spacecraft, an unacceptable risk of personal injury or loss of life". Guidelines for development of a CSI plan are found in the Joint Aeronautical Logistics Commanders (JALC) Aviation Critical Safety Item Management Handbook. As a minimum, the plan shall include specialized provisions for design and development, purchasing, production operations, test and inspection, installation, and configuration control as identified below. The plan shall map to lower tiered implementing instructions.

[Note: Separate CSI processes and documentation are not required where such processes are satisfied by other invoked technical/quality requirements]

#### 1. Design and Development:

a. Designation: Determination of CSIs and associated critical characteristics during performance of Failure Modes and Effects Analyses (FMEA), Hazard Analyses (HA), and other design and development activities.

b. Design Assurance: Determination of quality assurance and as-built configuration verification actions necessary to achieve confidence that specified critical design requirements are complied with. Such actions shall be developed in conjunction with Critical Item List (CIL) preparation and include, but are not limited to tests (laboratory, performance, environmental, etc.), non-destructive testing/evaluation, inspections, measurements, process witnessing, documentation, and validation of data relative to as-built item characteristics.

c. Configuration Identification: Clear and distinctive identification of CSIs on drawing material lists, planning documents, purchasing documents, and technical/logistics databases. Critical characteristics and required quality assurance actions shall be clearly called out on applicable technical/quality documents and shall be traceable to the identified CSI. Critical characteristics are any features such as material finish, composition, soundness, or mechanical properties, which if missing or nonconforming could cause failure or malfunction of the

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CSI. Technical requirements for CSIs shall be maintained on control drawings.

2. Purchasing:

a. Supplier Qualification: Identification of special qualification requirements for CSI suppliers (including pre-award survey, quality system audit/approval, qualified manufacturer certification, product qualification testing, and special process accreditation), and maintenance of a registry of suppliers that meet CSI qualification requirements.

b. Purchasing Information: Identification of special purchasing requirements applicable to CSI, including:

- 1) Mandatory tests and inspections (e.g., first article test, production lot test);
- 2) Delivery of material certification data (e.g., non-destructive testing certificates, chemical composition test reports, mechanical property certification);
- 3) Special process controls where uniform high quality cannot be ensured by inspection;
- 4) Sub-tier supplier flow-down of mandatory test/inspection requirements where critical attributes cannot be performed at a later point in time without destructive testing, uneconomical disassembly, or specialized gauges/equipment.

c. Verification of Purchased Product:

1) Acceptance/Certification: CSI product certification performed at the time of purchased item acceptance to validate compliance with specified critical characteristics, qualification requirements, and accomplishment of required quality inspections/tests (e.g., non-destructive testing). Validation of critical characteristics that require destructive testing (e.g., chemical composition, mechanical properties) shall be performed on a lot basis with no skip lots allowed.

2) Material Marking and Traceability:

a) Permanent physical application of alpha-numeric or machine readable markings that

- 1) indicate certification/acceptance;
- 2) provide traceability to certification data, including the date and place of production;
- 3) provide traceability to the item's design configuration (e.g., part number, drawing and item number). Traceability markings shall be unique for each item or manufacturing heat/pour/lot as defined by the applicable material specification.

b) Non permanent techniques such as item tagging are acceptable where permanent physical marking is not practicable due to size constraints or the nature of the product, or where such marking may cause material damage/degradation.

c) Traceability identification markings for raw materials shall remain legible/readable up until the time that a manufacturing process removes/obliterates the markings. These markings shall be annotated on inspection/planning documents prior to removal/obliteration and shall be traceable from the finished item certification data package.

d) Material markings for finished items shall be retained on the item and shall remain legible/readable for the life of the item.

3. Production Operations (Manufacturing/Fabrication/Assembly):

a. Material Control: Material storage, handling, fabrication, and installation requirements to prevent use of nonconforming CSI, maintain traceability identification markings, and to ensure installation of correct, certified, and traceable items.

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- b. Process Control: Compliance with SAE AS9103, Variation Management of Key Characteristics
  - c. Special Processes: Certification of internal and external sources responsible for performance of special processes.
  - d. Verification of Manufactured Product: CSI product certification performed at the time of item acceptance to validate compliance with critical characteristics and quality assurance actions.
  - e. Material Marking and Traceability: Material markings for manufactured items shall be performed in accordance with paragraph 2.c.(2) above. The markings shall identify the configuration of the manufactured part (e.g., part number) and shall provide traceability to the critical/certification attributes of both the raw material and the manufactured part.
4. Installation:
- a. Records: Documentation of CSI certification traceability markings on material planning or installation records at the time of final installation into a sub-assembly, finished assembly, sub-system or system, or prior to any point, after which traceability markings are no longer visible/readable. These documents shall be kept as configuration data.
  - b. As-Built Certification: Verification that installed items comply with as-designed configuration requirements unless formally departed by designated technical authority.
5. Test and Inspection (applicable to all phases of the CSI life cycle):
- a. Records: Documentation of CSI traceability identification markings on test and inspection records.
  - b. Calibration: Compliance with one of the following calibration standards for the measurement, test, or inspection of CSI: ISO 10012-1, ANSI/NCSL Z540-1.
  - c. All critical characteristics that can be non-destructively inspected/tested shall be subjected to 100% inspection.
  - d. Identification of special qualification/certification requirements for personnel responsible for inspecting/testing/accepting CSI.
6. General:
- a. Maintenance and Repair: The applicable CSI requirements identified in sections 2-5 above apply during maintenance and repair operations.
  - b. Configuration Control: All CSI non-conformances or departures related to critical characteristics, regardless of their classification, shall be forwarded to the NASA Contracting Officer for disposition.
  - c. Database: Design Database that provides for the rapid identification of the installed locations of CSI when keyed by certification traceability marking or product identification number/markings (e.g., part number).

134 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

- 13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the individual volume of the document requiring a change is required.

A Fault Tree Analysis shall be required to support the Flight Termination System Determination Analysis (DRD CEV-O-007)

The Fault Tree Analysis shall be updated as the design is changed or updated.

The following document(s) may be used as guidance:

- CXP-02004: Constellation Probabilistic Risk Assessment (PRA) Plan
- FTH: Fault Tree Handbook with Aerospace Applications, August 2002, version 1.1 (Chapters 1-9)

12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 3.1.  
Related DRD(s): CEV-S-001, CEV-S-003, CEV-S-009, CEV-S-010, CEV-S-011

13. **DATA PREPARATION INFORMATION:**

13.1 **SCOPE:**

The Fault Tree Analysis is a symbolic logic diagram showing the cause-effect relationship between a top undesired event (failure) e.g., Loss of Crew (LOC) and one or more contributing causes, including Meteoroid Orbital Debris (M/OD). It is a type of logic tree that is developed by deductive logic from a top undesired event to all subevents that must occur to cause it. Fault Tree Analyses shall identify hazards, evaluate risk, by identifying single failures and combinations of failures that result in hazards to the crew, the CEV system, and other Constellation Program elements.

A Fault Tree Analysis shall be developed in parallel and in support of design, development, and operational phases of the project. Multiple Fault Tree Analyses shall be developed to support the overall safety analysis in parallel and in support of design, development, and operational phases of the project.

The FTA shall be linked to the Hazards Reports by a unique tracking number. The cutsets shall be developed for the FTA and Common Cause Failure (CCF) Analysis performed on the most probable paths.

FTAs shall be utilized in developing hazard analyses required for the integrated system, all major subsystems, and all ground operations at the launch facility for every appropriate phase of operation.

The Fault Tree Analysis shall include hardware, software, and human failures.

13.2 **APPLICABLE DOCUMENTS:**

13.3 **CONTENTS:**

The Contractor shall perform a Fault Tree Analysis using the FTH, Fault Tree Handbook with Aerospace Applications, August 2002, version 1.1 (Chapters 1-9), and CXP-02004, Constellation Probabilistic Risk Assessment (PRA) Plan, as guidance to identify the top-level undesired events or hazardous conditions, and lower level relationships to verify that the functional failure tolerance requirements are met. From contract initiation until PDR, the scope will be limited to the 'avionics black box' level. Following the CEV PDR, this will be expanded to include more detail, potentially to the component level, in areas that are required to fully evaluate the design.

The final FTA shall provide evidence that the system is adequate to address the risks associated with the top-level event, in accordance with applicable documents to provide the following:

- (a) Top undesired event
- (b) Ground rules and assumptions.
- (c) Scope of analysis.
- (d) Fault tree symbols legend.
- (e) Fault tree logic symbols legend.
- (f) Diagram representation of the system being analyzed with associated logic and event/functions (tree diagram).
- (g) Summary of analysis results.
- (h) Most probable failure paths (i.e. cutsets)
- (i) For quantitative analysis, the data sources shall be referenced for the failure rate.
- (j) Link/track component failures to the Failure Modes and Effects Analysis and Critical Items List (FMEA/CIL) and hazards listed in the Hazard Reports.

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.





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occur to cause it. It shall identify hazards, evaluate risk, by identifying single failures and combinations of failures that result in hazards to the crew, the CEV system, and other Constellation Program elements. This structured methodology shall be performed to identify the top-level undesired events or hazardous conditions, and lower level relationships to the degree necessary to provide the level of detail to fully evaluate the adequacy of the design as related to the identified safety problem.

At PDR the following level of maturity is required:

- (a) Accident scenarios, hazard sources, and environment hazards are mature, understood and documented.
- (b) (SSHA, SHA) System /subsystem level failure induced hazards, facility, interface, and human error hazards are at a comparable level of detail to the design.
- (c) Draft Integrated Hazard Analysis is provided.
- (d) Causes and controls are at a comparable level of detail to the design System and subsystem hazard analysis has begun.
- (e) Generic hazards from PHA are incorporated.
- (f) Hazards identified to more detailed level comparable to the design
- (g) Acceptance rationale may be developed while hazard controls design matures to the level comparable to the current level of design.

At CDR the following level of maturity is required:

- All Subsystem and System hazard analyses should be completed. •  
System/subsystem level failure induced hazards, facility, interface, and human error hazards are at a comparable level of detail to the design.
- (a) Causes and controls are at a comparable level of detail to the design System and subsystem hazard analysis has begun.
  - (b) Acceptance rationale for components/subsystems that can not be controlled by design are developed.

At FRR the following level of maturity is required:

- (a) System Hazard Analysis (SHA) / Subsystem Hazard Analysis (SSHA) complete
- (b) Ops and Support hazard Analysis completed and approved

A Constellation System Safety Working Group (SSWG) will be established among the Constellation Program, CEV Project, supporting NASA Centers, Element Contractors and applicable Safety Review Panels to review hazard definitions, analysis methodologies, and hazard control and mitigation techniques to support an effective System Safety Program.

After the Phase 3 Safety Review, new hazard reports that result in increased risk shall be submitted at least 30 days prior to a mission's Flight Readiness Review.

All open Hazard Reports will be forwarded for status tracking.

For the Verification tracking List:

- (a) Initial submission: 60 days prior to the Phase 3 Safety Review of the subject hardware.
- (b) Final mission submission: 30 days prior to flight

Depending on the control verification status, this deliverable will be required for each mission until all hazard control verifications are complete.

12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 3.1.  
Referenced from SOW Paragraph(s): 3.2, 9.2  
Related DRD(s): CEV-S-001, CEV-S-002, CEV-S-009

## **Crew Detects Odor, Atmosphere Recovery Efforts Under Way**

An emergency was declared on the International Space Station shortly before 7:30 a.m. EDT when the Expedition 13 crew reported an odor in the Russian segment. Recovery efforts are now under way by scrubbing the atmosphere.

Expedition 13 Commander Pavel Vinogradov reported to Russian flight controllers at about 7:45 a.m. that the situation had stabilized and that he cleaned up a chemical near the Elektron oxygen generation system.

Flight controllers instructed the crew to put on protective equipment – goggles and gloves. The source of the smell may be potassium hydroxide.

NASA ISS Science Officer Jeff Williams has been in close contact with Mission Control Houston.

## STS-115 Crew Completes Inspections

Trailing 50 miles behind the International Space Station, the STS-115 crew conducted an inspection of Space Shuttle Atlantis's heat shield this morning.

The crew used the robotic arm and boom sensor system to ensure that the orbiter's leading wing edges and nose cap had not received damage from space junk and micrometeoroids.

Also on today's work schedule is the stowage of items in preparation for the return to Earth. Otherwise, it is a light day of duty for the crew members.

Atlantis is scheduled to touch down at 5:57 a.m. Wednesday at the Shuttle Landing Facility at Kennedy Space Center, Fla. Landing will bring to an end STS-115's successful mission to the International Space Station.

Atlantis delivered the P3/P4 integrated truss to the station on Sept. 11. The STS-115 and Expedition 13 crews used the shuttle and station robotic arms to attach the truss to the orbital outpost. Then, STS-115 astronauts conducted three spacewalks in four days to prepare the truss and its solar arrays for operation. Atlantis departed the station at 8:50 a.m. Sunday.

## **ATTACHMENT J-2**

### **DATA PROCUREMENT DOCUMENT**

## 1.0 INTRODUCTION

1.1 Scope: Subject to the Rights in Data clause, this Data Procurement Document (DPD) sets forth the data requirements in each Data Requirements Description (DRD) and shall govern that data required by the DPD for the contract. The Contractor shall furnish data defined by the DRD's listed on the Data Requirements List (DRL) by category of data, attached hereto, and made a part of this DPD. Such data shall be prepared, maintained, and delivered to NASA in accordance with the requirements set forth within this DPD. In cases where data requirements are covered by a Federal Acquisition Regulation (FAR) or NASA FAR Supplement (NFS) regulation or clause, the regulation will take precedence over the DPD, per FAR 52.215-8.

1.2 DPD Description: This DPD consists of an Introduction, a Statement of General Requirements, DPD maintenance procedures, a DRL, and the DRD's.

1.2.1 General Requirements: The general requirements, as specified in paragraph 2.0 of this DPD, prescribe those requirements applicable to the preparation, maintenance, and delivery of data that are better defined in aggregate than in the individual DRD's.

1.2.2 Data Requirements List (DRL): Throughout the performance of the contract, the DRL provides a listing by data category of the data requirements of the DPD.

1.2.2.1 The DRL and the Data Requirements Matrix (DRM) are the same under this contract.

1.2.2.2 The following definitions apply for submission activities:

Initial – First release of a document.

Update – Update to a document.

Final – Baseline version of the document. The baseline version of the document shall be maintained and updated as required throughout the life of the contract.

1.2.3 Data Requirements Descriptions (DRD's)

1.2.3.1 Each data requirement listed on the DRL is given complete definition by a DRD. The DRD prescribes content, format, maintenance instructions, and submittal requirements.

1.2.3.2 For the purpose of classification and control, DRD's of this DPD are grouped into the following broad functional data categories:

<u>CATEGORY SYMBOL</u>	<u>DESCRIPTION</u>
B	Business
D	Demo
M	Management
O	Operations
S	Safety
T	Technical

1.2.3.3 The symbols representing these data categories form part of the prefix of the DRD identification number. The numerical characters reflect the DPD number.

1.2.3.4 To facilitate the usage and maintenance of the DPD, the DRD's have been divided into sections in accordance with the above data categories.

1.2.3.5 The DRD's are filed by data category and are in alpha-numeric sequence as listed on the DRL pages that precedes the DRD's.

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1.2.4 DPD Maintenance Procedures: Maintenance procedures define the detailed methods to be employed in maintaining the DPD. Detailed maintenance procedures are specified in paragraph 3.0 of this DPD

1.3 Data Types for Contractual Efforts: The types of data and their contractually applicable requirements for approval and delivery are:

TYPEDESCRIPTION

- 1 All issues and interim changes to those issues require written approval from the requiring organization before formal release for use or implementation.
- 2 NASA reserves a time-limited right to disapprove in writing any issues and interim changes to those issues. Data shall be submitted to the procuring activity for review not less than 45 calendar days prior to its release for use or implementation. The Contractor shall clearly identify the release target date in the "submitted for review" transmittal. If the Contractor has not been notified of any disapproval prior to the release target date, the data shall be considered approved. To be an acceptable delivery, disapproved data shall be revised to remove causes for the disapproval before its release.
- 3 These data shall be delivered by the Contractor as required by the contract and do not require NASA approval. However, to be a satisfactory delivery, the data must satisfy all applicable contractual requirements.
- 4 These data are produced or used during performance of the contract and are retained by the Contractor. They shall be delivered when NASA requests it according to instructions in the request. The Contractor shall maintain a list of these data and shall furnish copies of the list to NASA when requested to do so.
- 5 These data are incidental to contract performance and are retained by the Contractor in those cases where contracting parties have agreed that formal delivery is not required. However, the Contracting Officer or the Contracting Officer's Representative shall have access to and can inspect this data at its location in the Contractor's or subcontractor's facilities, or in an electronic database accessible to the Government.

## 2.0 STATEMENT OF GENERAL REQUIREMENTS

2.1 Applicable/Reference Documents: Documents included as applicable documents in this DPD are the issue specified in the Statement of Work, and form a part of the DPD to the extent specified herein. Applicable documents listed in Item 13.2 of a DRD are applicable only to the preparation of the deliverable documentation described by that DRD.

References to documents other than applicable documents in the data requirements of this DPD may sometimes be utilized, and shall be indicated in 11, Remarks of the DRD. These do not constitute a contractual obligation on the Contractor. They are to be used only as a possible example or to provide related information to assist the Contractor in developing a response to that particular data requirement.

### 2.2 Subcontractor Data Requirements

2.2.1 The Contractor shall specify to subcontractors and vendors, if any, the availability source of all data required for the satisfactory accomplishment of their contracts. The Contractor shall validate these requirements for documents when appropriate; where the requirement concerns other Contractor data, the Contractor shall provide his subcontractor or vendor with the necessary documents. All such requests shall be accomplished under the auspices of the Contractor.

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- 2.2.2 Reference to subcontractor data in the Contractor's responses is permissible, providing the references are adequate and include such identification elements as title, number, revision, etc., and a copy of the referenced data is supplied with the response document at time of delivery to NASA.

2.3 Data Distribution, Format and Transmittal

- 2.3.1 Distribution: Distribution of required documentation shall be in quantities determined by the Contracting Officer. Recipient names and email addresses shall be noted on a separate distribution list to be furnished by the Contracting Officer. The Contracting Officer's letter may include other information pertinent to delivery of data, as required

2.3.2 Format

- 2.3.2.1 Electronic Format: Electronic submission of data deliverables is required. Electronic deliverables shall be printable where possible. The Contractor will not be required to deliver the data in a printable format for data deliverables such as binary executables, CAD models, mathematical models, etc. which are not printable. The versions of all submittals shall be confirmed prior to delivery such that the delivered version corresponds to the intended delivered version.

Data deliverables outlined by each DRD shall be delivered to NASA in the format specified by the NEXIOM. NEXIOM formats will be governed by the NEXIOM Working Group. NEXIOM will govern both acceptable formats for data deliverables called out in each DRD as well as *metadata* that must accompany each delivery product. NEXIOM-mandated meta-information will be expressed in XML and be governed by the NEXIOM Working Group. This accompanying meta-data must be conformant to the following standard: CXP-02016, NEXIOM Standard for Data Deliverables. All deliverables will consist of at least the deliverable itself and accompanying meta-information.

Software tools, models or simulations made available to NASA shall be accompanied by an XML metadata document conformant to the following schema: CXP-02017, NEXIOM Standard for Tool, Model and Simulation Deliveries. When a tool, model or simulation is used to produce or support a DRD-governed deliverable or CEV program milestone, an indication of the tools, models and simulations used shall be supplied conformant to the CXP-02016, NEXIOM Standard for Data Deliverables metadata document accompanying the DRD or milestone data.

Data submittals in MS Word, MS Project, Excel or PowerPoint shall consist of a single, searchable Adobe Acrobat PDF file in addition to the native Word, Excel, Project or PowerPoint electronic file(s). Where data submittals are not an MS Word, MS Project, Excel or PowerPoint product, the NEXIOM-conformant format for the deliverable and the native format electronic file(s) (if different than the NEXIOM format) shall be submitted. When data deliverables are called out in document or report form, any underlying data products (e.g. table data, chart data, requirements databases, process/procedure models, databook content etc ...) must also be provided according to NEXIOM format.

Where a single native format file is not possible, multiple files may be integrated into a single ZIP file for submission with the concurrence of NASA. The organization of the contents of the integrated ZIP file must be made readily apparent to the reader, and each file within the integrated product shall be clearly identifiable and traceable within the organization of the integrated product.

All native format files delivered by the Contractor shall be readable by COTS software. Where the native file formats are not readable by COTS software, and with the concurrence of the NASA COTR, the Contractor shall deliver the application (source code and executable) required in order to read the native file format. The preferred format for CAD data will be Pro Engineer. The Contractor may request an alternative format.

- 2.3.2.2 Hardcopy Format: In addition to the electronic submittal, one hardcopy package of specific data deliverables shall be delivered to the NASA Contracting Officer for the Government contract file

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DRD's which require hardcopy submittals will indicate this in Item 13.4, Format. The hardcopy package shall consist of the Contractor's Transmittal Memo and one copy of the data deliverable.

**2.3.3 Transmittal**

2.3.3.1 Data shall be transmitted to NASA via the Integrated Collaborative Environment (ICE) in accordance with Attachment J-14, hardcopy, or other mechanism agreed to by the Contracting Officer, COTR, and Project representatives who are responsible to receive, index, and store the data deliverables

2.3.3.2 **Data Transmittal Package:** Each data transmittal package shall include:

- a. Transmittal memorandum that specifies the meta-data below for each data transmittal:
  1. Contract number.
  2. Data Requirements Description (DRD) number.
  3. DRD data type (specified in Item 3 on the DRD).
  4. Submission date or milestone being satisfied.
  5. Document number and revision
  6. Document title.
  7. File names of all files being delivered; multiple files per document must be clearly related to the document.
  8. Distribution (as defined by the Contracting Officer's letter).
  9. Requested response date.
- b. Printable electronic files or hardcopy data.
- c. NEXIOM meta-data document per section 2.3.2.1

2.3.4 **Use of the ICE Repository:** See J-14, ICE Operating Environment for details on using the ICE repository.

2.4 **Printing:** All printing, duplicating, or binding shall be in accordance with NFS 1852.208-81, Restrictions on Printing and Duplicating. Printing of formal reports and Type 1 and 2 data in book format shall be in accordance with the following general specifications:

- a. Method of reproduction – offset/xerography.
- b. Finished size – 8 1/2" X 11".
- c. Paper – 20-pound opaque bond.
- d. Cover – Litho cover stock.
- e. Pages will be printed on both sides; blank pages will be avoided when possible.
- f. Oversize pages will be avoided when possible, but if necessary will be folded to 8 1/2" X 11".
- g. Binding shall be the most economical method commensurate with the size of the report and its intended use.

2.5 **Contractor's Internal Documents:** The Contractor's internal documents shall be used to meet the data requirements of this DPD unless a specific format is required by the applicable DRD. The format being used by the Contractor's internal documents shall be readable by COTS tools.

2.6 **Document Identification:** Type 1 and 2 documents published by the Contractor and submitted in response to the data requirements of this DPD shall be identified within an organized identification numbering system prescribed to NASA by the Contractor and, if applicable, as approved by NASA. This number, change legend, date, and title constitute the minimum identification of the specific document and shall appear on the cover and title page. The contract number shall also appear on the cover and title page as separate markings. The originator and organization shall be included on the title page. The document number, change legend, and date shall appear on each page of the document. In the front matter of each document, identify the DPD number and applicable DRD number(s) required for document preparation. Successive issues or revisions of documents shall be identified in the same manner as the basic issue and shall have appropriate change identification. Drawings and ECP's are excluded from the marking provisions of this paragraph. All Type 1 documentation, excluding configuration management requirements, will be marked



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"PRELIMINARY PENDING NASA APPROVAL," and once approved shall be reissued with "APPROVED BY NASA" and the date and approval authority annotated on the cover.

2.7 Reference to Other Documents and Data Deliverables in Data Submittals: All referenced documents shall be made readily available to the cognizant NASA organization upon request. The Contractor should make sure that the references are available to NASA in a manner which does not incur delays in the use of the response document. Reference may be made, within one data submittal, to other data submittals delivered in response to this DPD in those cases where the data required by one DRD may have been delivered by the Contractor in response to another DRD. The reference to previously-submitted data shall include the applicable DRD number, data submittal version date, and location within the referenced document.

2.8 Maintenance of Type 1 Document Submittals

2.8.1 Revisions of Type 1 documentation may be accomplished either by individual page revision or by a complete reissue of the document identified in accordance with requirements of 2.7 above, with the exception of drawings (which shall be revised in accordance with contract configuration management requirements).

2.8.2 Individual page revisions shall be made as deemed necessary by the Contractor or as directed by the Contracting Officer.

2.8.3 A Type 1 document shall be completely reissued when, in the opinion of the Contractor and/or NASA, the document has been revised to the extent that it is unusable in its present state, or when directed by the Contracting Officer. When complete reissues are made, the entire contents of the document shall be brought up to date and shall incorporate revised pages. All revisions shall be recorded. A revision log shall identify complete reissues except for periodic reports and documents which are complete within themselves as final.

2.8.4 Changes of a minor nature to correct obvious typing errors, misspelled words, etc., shall only be made when a technical change is made, unless the accuracy of the document is affected.

2.8.5 All revised pages shall be identified by a revision symbol and a new date. Each document shall contain a log of revised pages that will identify the revision status of each page with the revision symbol. This list shall follow the table of contents in each document. The line or lines revised on a given page shall be designated by the use of vertical line in the margin of the page, and the change authority shall be indicated adjacent to the change.

2.8.6 Contractor Type 1 documents shall not be submitted containing pen and ink markups which correct, add to, or change the text, unless schedule problems exist and approval is obtained in writing from the Contracting Officer. Such markups, however, shall not exceed 20 percent of the page content and shall be acceptable provided that the reproduced copies are legible. In addition, hand-drawn schematics, block diagrams, data curves, and similar charts may be used in original reports in lieu of formally prepared art work, as long as legibility of copies is not impaired. Acceptability will be determined by the Contracting Officer.

3.0 DPD MAINTENANCE PROCEDURES

3.1 NASA-Initiated Change: New and/or revised data requirements will be incorporated by contract modification to which the new or revised portion of the DPD will be appended. The Contractor shall notify the Contracting Officer in the event a deliverable data requirement is imposed and is not covered by a DRD, or when a DRD is changed by a contract modification and for which no revision to DPD is appended. In such cases, the Contractor shall submit the requested changes to NASA for approval. See paragraph 3.3.1 for change procedures.

3.2 Contractor-Initiated Change: Contractor-proposed data requirements, or proposed changes to existing requirements shall be submitted to NASA for approval.

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3.3 DPD Change Procedures

- 3.3.1 Changes to a contractual issue of this DPD will be identified by NASA on the Document Change Log and Page Revision Log. The actual revised material on the DPD page will be identified by placing a heavy vertical line in the right-hand margin extending the entire length of the change. In addition, the numerical control number of the contractual direction authorizing the change shall be placed adjacent to the vertical revision line. These revision identifiers shall be used to reflect the current revision only; any previous symbols on a page will be deleted by the current revision.
- 3.3.2 The date of the contractual direction paper, e.g., Change Order, Supplemental Agreement, or Contracting Officer's letter shall be entered under the "Status " column of the Page Revision Log adjacent to the affected page or DRD number, and in the "as of" block. The date that was in the "as of" block will be entered in the "Superseding" block.
- 3.3.3 The Document Change Log entitled "Incorporated Revisions" will be changed to indicate the number, portions affected, and associated Supplemental Agreement number, if applicable.
- 3.3.4 The Document Change Log entitled "Outstanding Revisions" is changed periodically to indicate outstanding Change Orders and Contracting Officer notification letters.

3.4 DPD Reissues

- 3.4.1 When conditions warrant, the DPD will be reissued by NASA and will supersede the existing DPD in its entirety. Reissues will be issued by contractual direction.
- 3.4.2 All revision symbols (vertical lines and contractual direction control numbers) will be removed from all pages; revision dates shall remain in the Date Revised block on DRD's that have been revised. The issue symbol, which will commence with "A" and progress through "Z," will be entered in the DPD identification block of each DRD page of the DPD.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-B-001
3. **DATA TYPE:** 3
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Financial Management Report (533)
7. **DESCRIPTION/USE:**  
The NASA Form 533 (NF533) reports provide data necessary for the following:
  - a) Projecting costs and hours to ensure that dollar and labor resources realistically support project schedules.
  - b) Evaluating Contractor's actual cost and fee data in relation to negotiated contract value, estimated costs, and budget forecast data.
  - c) Planning, monitoring, and controlling project resources.
  - d) Accruing cost in NASA's accounting system, providing project and functional management information, and resulting in liabilities reflected on the financial statements
8. **DISTRIBUTION:** As Determined by the Contracting Officer  
Per Data Requirements Matrix
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
The due dates for the NF533M and NF533Q reports are outlined in Chapter 3 of NPR 9501.2D. The following is a summary of the NF533 due date requirements:
  - a) NF533M: Due not later than 10 working days following the close of the Contractor's monthly accounting period.
  - b) NF533Q: Due not later than the 15th day of the month proceeding the quarter being reported.

The due dates reflect the date the NF533 reports are received by personnel on the distribution list, not the date the reports are generated or mailed by the contractor. It is critical that the NF533 reports are submitted in a timely manner to ensure adequate time for NASA to analyze and record the cost into the NASA accounting system.

533 M and Q reporting should reflect costs at WBS Level 3 with the exception of Systems Engineering and Integration and Spacecraft, which shall be reported at Level 4.

533 reports by WBS should include summary pages for WBS levels 1 and 2 that equal the sum of all lower level WBS costs contained in the report.

The following document(s) may be used as guidance:

  - 533 DRD-eCCR: 533 Electronic Submission Example
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 1.2.1.

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## 13 DATA PREPARATION INFORMATION:

## 13.1 SCOPE:

NF533 Monthly and Quarterly Cost Reporting. The M/Q report shall provide a report for projecting costs and equivalent personnel (EP's) for evaluating Contractor's actual cost and fee, for the planning, monitoring, and controlling of project and program resources, and for accruing cost.

## 13.2 APPLICABLE DOCUMENTS:

NPD 9501.1G: NASA Contractor Financial Management Reporting System  
NPR 9501.2D: NASA Contractor Financial Management Reporting

## 13.3 CONTENTS:

An initial NF533 report is required in the NF533Q format to be used as a baseline for the life of the contract. The initial (baseline) NF533Q report shall be submitted by the contractor within 30 days after authorization to proceed has been granted. The initial report shall reflect the original contract value detailed by negotiated reporting categories and shall be the original contract baseline plan. In addition to the initial (baseline) report, monthly NF533 reporting shall begin no later than 30 days after the incurrence of cost.

Column 7b (planned cost incurred/hours worked for the month) and 7d (cumulative planned cost incurred/hours worked) of the NF533M represent the negotiated baseline plan for the contract. There may not be a relationship between the estimates provided in columns 8 of the NF533M to columns 7b and 7d. Columns 7b and 7d represent the legally binding contract negotiated baseline plan plus all authorized changes.

Short and long-term cost estimates, which include all data entered in columns 8 and 9a on the NF533M and NF533Q reports, shall be based on the most current and reliable information available.

Prior period cost adjustments should be reported in column 7a and 7c of NF533M and column 7a of the NF533Q with a footnote discussing the reasons for and amounts of the adjustments.

Monthly NF533 reporting is no longer required once the contract is physically complete, provided the final cost report includes actual cost only (no estimates or forecasts). The contractor must continue to submit monthly NF533 reports as long as estimates for the following period are included. If the final cost of a contract changes after the submission of the 'final' contractor cost report, the contractor must submit a revised NF533 report in the month the cost change is recognized.

## Electronic NF533 Requirement

In addition to submitting the NF533M or NF533Q in a hardcopy format, the contractor, upon request, shall submit the NF533 electronically by the same due date as the hardcopy. The data shall be submitted via email using the Government prescribed flat file format (see attached Agency Defined File Format for an example of the layout details) and shall include the following header information from the hardcopy.  
<insert table 1 here>

The flat file will also contain detail information for each Reporting Category (RC). A Reporting Category correlates to a task order, delivery order, or Work Breakdown Structure (WBS) and is the level at which cost is reported. Each RC can have Sub-Reporting Category line items (detailed cost elements) that add up to a RC. The Contractor is required

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to coordinate with the NASA Resource Analyst assigned to the contract in order to establish and maintain the Reporting Categories the contractor shall use to comply with this data requirement. The chart below describes the data elements to be included in this section of the flat file (see attached Agency Defined File Format for specific layout details).

<insert table 2 here>

The flat file shall be saved as a text file with no extension (do not include .txt after the file name) and named in strict accordance with the specific format described in the attached Agency Defined File Format document.

## Distribution:

LF6 Cost Accounting (1 hardcopy)

\_\_\_\_\_ Contracting Officer (1 hardcopy)

\_\_\_\_\_ Budget/Program Analyst (1 hardcopy)

\_\_\_\_\_ Technical (1 hardcopy)

\_\_\_\_\_ Upon Request, E-mail Account (1 electronic copy)

File names must be provided in a specific format. Each file name will begin with the SAP 2 Character center abbreviation listed below. The contract number and date will be included in the file name as well. Below is a sample file name.

MACFPS001\_NAS00-0001\_yyyy\_mm\_dd

<insert table 3 here>

SAP 2 Charter Center Abbreviations

Reference sample format ' 533DRD-eCCR.'

- 134 **FORMAT:** Cost Elements      Definitions  
Labor Reported to NASA as hours are incurred.

Equipment & Materials (commercial off-the-shelf)  
Generally reported to NASA when received and accepted by the Contractor.

## Manufactured Equipment

Defined as any equipment that is produced to specific requirements that make it useless to anyone else without rework. Cost should be reported to NASA as the equipment is being manufactured. The straight-line method for estimating accrued costs or the use of supplemental information obtained from the vendor are acceptable methods used to calculate the cost accrual amount.

Leases Reported to NASA using a proration over the life of the lease.

Travel Reported to NASA as costs are incurred.

Subcontracts Actual and estimated costs reported by prime Contractor's shall include subcontractors' incurred costs for the same accounting period. Where subcontract costs are material, they should be separately identified on NF533 reports. The prime Contractor shall include in the total cost of each subdivision of work the accrued cost (including fee, if any) of related subcontractor effort. Subcontractors should, therefore, be required to report cost to the prime Contractor, using the accrual method of accounting. If the G&A and fee reported by a subcontractor are at the total subcontractor level, these costs must be allocated to specific sub-divisions of work. Data submitted by the subcontractor should be structured similarly to the prime Contractor's NF533 to enable the prime Contractor to properly report to NASA. For

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firm fixed price subcontracts with a contract value greater than \$500,000, the prime Contractor is required to document the methodology used to generate the sub-contractor costs reported and provide this information to the Contracting Officer and Center Deputy Chief Financial Officer (Finance).

**Unfilled Orders**

Reported as the difference between the cumulative cost incurred to date and amounts obligated to suppliers and subcontractors

**Fee**

Should be accrued as earned using a consistent and auditable method to determine the amount. For example: an acceptable method would be to use historical data to determine the amount to accrue each month. Fee should be reported on the NF533 following the 'Total Cost' line. Award fee must be reported by the following categories: Base Fee, Fee Earned, Interim Fee, Provisional Fee, Potential Additional Fee, and Total Fee. If any of the above fee categories do not pertain, they should not be included in the NF533.

**Prompt Payment Discounts**

Cumulative cost reported to NASA should be the full incurred cost. The prompt payment discount amount taken should be reported as a separate line item on the NF533 below the cumulative cost amounts for the contract.

- 13.5 **MAINTENANCE:** The Contractor shall provide a revised NF533M immediately to correct errors when deemed necessary by the NASA Financial Management Division. The revised NF533M shall be delivered prior to closure of the current JSC account system for the month. The reports shall be maintained electronically by the Contractor.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

- |    |                     |    |                      |           |
|----|---------------------|----|----------------------|-----------|
| 1. | <b>PROGRAM:</b> CEV | 2  | <b>DRD NO.:</b>      | CEV-B-002 |
| 3  | <b>DATA TYPE:</b> 3 | 4. | <b>DATE REVISED:</b> | 11/1/2005 |
|    |                     | 5. | <b>PAGE:</b>         | 1         |
- 6     **TITLE:** Workforce Reporting
- 7     **DESCRIPTION/USE:**  
The report is used by NASA to provide workforce information to center management. The supplemental report is used by NASA Headquarters to support congressional inquiries.
- 8     **DISTRIBUTION:** As determined by the Contracting Officer
- 9     **INITIAL SUBMISSION:** Per Data Requirements Matrix
- 10    **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
- 11    **REMARKS:**
- 12    **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 1.2.2.
- 13    **DATA PREPARATION INFORMATION:**
- 13.1   **SCOPE:**  
The reports provide workforce data by geographic location.
- 13.2   **APPLICABLE DOCUMENTS:**
- 13.3   **CONTENTS:**  
The Semi-Annual workforce report should provide Equivalent Personnel (EPs) by location, specifically on or near site (NASA center), and by state for workforce outside of the responsible NASA center area. The report shall include contract labor, subcontract labor, and purchased labor. The data should be reconcilable to other financial deliverables. The content and frequency of the supplemental workforce report may vary based on specific direction provided by NASA Headquarters to support congressional inquiries. It's most common form is an annual request to provide workforce data by state, congressional district, or Zip Code.
- 13.4   **FORMAT:** Semi-Annual submissions: Electronic format per Section J-2 2.3.2.1.  
Supplemental Submissions: Specific formatting will be mutually agreed upon by the Contractor and NASA
- 13.5   **MAINTENANCE:** Supplemental Management Information Reports shall be submitted but should reconcile with the NF533.

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1      PROGRAM: CEV
3      DAIA TYPE: 2

6      IITLE: Cost Performance Report

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2. **DRD NO.:** CEV-B-003  
4. **DATE REVISED:** 12/21/2005  
5 **PAGE:** 1

This Data Requirements Description (DRD) contains the format and content preparation instructions for the data product generated by the specific and discrete task requirement as delineated in the contract. This report consists of two major sections. The first section is the Contractor Integrated Management Schedule and the second section contains the cost reporting formats.

a.1. The prime Contractor is required to include significant external interfaces and critical items from suppliers, teammates, or other detailed schedules that depict significant and/or critical elements and Government furnished equipment or information dependencies for the entire contractual effort in a single integrated network. The determination of significant and critical shall be defined and documented, and agreed to by NASA.

b. The five cost reporting formats contain data for measuring contractors' cost and schedule performance on the NASA Crew Exploration Vehicle (CEV) acquisition contract. Format 1 provides data to measure cost and schedule performance by product-oriented Work Breakdown Structure (WBS) elements, the hardware, software, and services the Government is buying. Format 2 provides the same data by the Organization Breakdown Structure (OBS) elements. Format 3 provides the budget baseline plan against which performance is measured. Format 4 provides staffing forecasts for correlation with cost estimates. Format 5 is a narrative report used to explain significant cost and schedule variances and other identified contract problems and topics. CPR data shall be used by NASA project management to: (1) integrate cost and schedule performance data with technical performance measures, (2) identify the magnitude and impact of actual and potential problem areas causing significant cost and schedule variances, and (3) provide valid,



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timely project status information to higher management. The CPR is a management report. It provides timely, reliable summary-level data with which to assess current and projected contract performance. The CPR's primary value to NASA is its ability to reflect current contract performance measurement status and reasonably project future contract performance. It is important that the CPR be as accurate as possible so it may be used for its intended purpose, which is to facilitate informed, timely decisions. It will be used by the NASA component staff, including project and program managers, engineers, cost estimators, and financial management personnel, to confirm, quantify, and track known or emerging contract problems and serve as a basis for communicating with the contractor. The CPR data shall accurately reflect how work is being planned, performed, and measured and shall be consistent with the actual contract status.

c. The CPR shall be used to obtain cost and schedule performance information. Refer to the Federal Acquisition Regulation (FAR) or Federal Acquisition Regulation Supplement clause on contract. The CPR data elements shall reflect the output of the contractor's integrated management system which shall be compliant with the American National Standards Institute/Electronic Industries Alliance Standard 748 (ANSI/EIA-748), Earned Value Management Systems (EVMS) (current version in effect at time of contract award)

c.1 The CPR is a crucial element of NASA's Continuous Cost-Risk Management (CCRM) process (Step 9) providing the NASA Project Manager high quality, timely cost-risk feedback for cost management improvement. Whereas the level of detail to be reported in Format 1 normally will be at level three of the WBS, for CCRM implementation purposes earned value cost performance data for medium and high-risk WBS elements listed below shall be reported on CPR Formats 1 & 2 until such time as both government project management and the contractor agree that they no longer represent medium or high risks. This reporting should be at a level that is adequately sensitive to performance measurement indicators to ensure earliest identification of cost and schedule problems caused by the source risks. The Contractor shall identify known risks if not provided in the list above and track their performance measurement in the same manner. NASA reserves the right to amend the above list at the appropriate time during source selection, at Final Proposal Revision (FPR), and at any time during the effort as new information on risks becomes available. NASA and the Contractor shall periodically review and adjust as necessary WBS reporting levels on Format 1 to ensure they continue to provide appropriate visibility without requiring excessive information. If there is a significant problem at a lower level, detailed reporting for that WBS element shall be required until the problem is resolved.

c.2 All five formats are mandatory in all cases.

c.3 Significant variances require problem analysis. The thresholds for significant variances are:

	Cum-to-Date	Current Month	At Completion
Schedule Variance	+/-10% and +/- \$100k	+/-10% and +/- \$50k	
Cost Variance	+/-10% and +/- \$100k	+/-10% and +/- \$50k	+/- \$5M

8. **DISTRIBUTION:** As determined by the Contracting Officer
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix.

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**11. REMARKS:**

The Cost Performance Report shall be available for online viewing at any time during the effort by NASA using appropriately protected Internet/Intranet technologies.

The CPR shall be submitted monthly by the 10th to 12th working day of the month following the month being reported.

The time increments to be used in Format 3 will correspond (within the limits of the Contractor's disclosed fiscal calendar) with the government fiscal year

CPR reporting shall reflect costs at WBS Level 3 with the exception of Systems Engineering and Integration, which shall be reported at Level 4, and Spacecraft, which shall be reported at Level 5.

CPR reporting shall include the flow down of EVM requirements to subcontractors as well as any reimbursable agreements with other government agencies.

For a detailed discussion of CCRM, see [www.ceh.nasa.gov](http://www.ceh.nasa.gov).

The following document(s) may be used as reference:

- 533 DRD-eCCR: 533 Electronic Submission Example
- CPR Formats 1-5: CPR Formats 1 through 5

**12. INTERRELATIONSHIP: Parent SOW Paragraph(s): 1.1.8, 1.2.5.****13. DATA PREPARATION INFORMATION:****13.1 SCOPE:**

The Cost Performance Report (CPR) includes data to measure cost and schedule performance. The CEV Integrated Master Schedule provides data for the assessment of contract schedule and logic network of the tasks to be performed.

**13.2 APPLICABLE DOCUMENTS:**

ANSI/EIA-748-98: Earned Value Management Systems  
NPD 9501.3A: Earned Value Management  
NPR 9501.3: Earned Value Management Implementation Plan on NASA Contracts

**13.3 CONTENTS:**

13.3.1. The integrated master schedule shall contain the contract milestones, accomplishments, and discrete tasks/activities (including planning packages where applicable) from contract award to the completion of the contract. The schedule shall be an integrated, logical network-based schedule that correlates to the CWBS, and is vertically and horizontally traceable to the cost/schedule reporting instrument used to address variances such as the CPR. The schedule shall have a numbering system that provides traceability to the IMP and SOW. It shall contain contractual milestones and descriptions and display summary, intermediate, and detailed schedules, and periodic analysis of progress to date. It shall include fields and data that enable the user to access the information by product, process, or organizational lines.

13.3.2. Contract Milestones and Definitions. Key project events, which define progress and completion for each CWBS element, along with the definition for successful completion of the milestone.

13.3.3. Summary Master Schedule. A top-level schedule of key tasks/activities and milestones at the summary level of the CWBS and IMP (if applicable). It shall be an integrated roll up of the intermediate

## Crew Exploration Vehicle - (CEV)

and detailed schedules (see 13.3.3 and 13.3.4) (vertical integration).

13.3.4. Intermediate Schedules. Midlevel contract schedules that include key tasks/activities and milestones and all associated accomplishments in the summary master schedule, traceable to the CWBS element or IMP event as necessary to display work effort at the intermediate level of summarization. There may be several intermediate schedules that depict varying levels of detail. They shall be integrated roll ups of the detailed schedules (see 13.3.4 below) (vertical integration).

13.3.5 Detailed Schedules. The lowest level of contract tasks/activities that form the network. The detailed schedules shall contain horizontal and vertical integration, as a minimum, at the work package and planning package level. The detailed schedules shall include all tasks/activities, work packages, and planning packages identified in the contract Performance Measurement Baseline (PMB). Every discrete task/activity, work package, and planning package shall be clearly identified and directly related to a control account. Work packages and planning packages shall be individually represented and summarize to or reconcile with the total budget for that control account. If Level of Effort (LOE) control accounts, work packages, or planning packages are included as tasks in the IMS, they shall be clearly identified as such. The detailed tasks/activities, work packages, and planning packages shall be traceable to only one CWBS, IMP, and performing organizational element, as applicable. The level of detail in the IMS (including number and duration of tasks/activities) shall follow the Contractor's EVM process as documented in the EVMS system description, project directives, etc. Shorter-term work packages (ideally equal in length to the statusing interval) are preferred because they provide more accurate and reliable measures of work accomplished.

13.3.6. Key Elements of Detailed Schedules. The key elements of the detailed schedules include the following:

13.3.6.1. Task/Activity. An element of work with duration.

13.3.6.2 Milestone. A specific definable accomplishment in the contract network, recognizable at a particular point in time. Milestones have zero duration and do not consume resources.

13.3.6.3 Duration. The length of time estimated (or realized) to accomplish a task/activity.

13.3.6.4 Percent Complete (Schedule). The proportion of an activity or task that has been completed to time now. This usually involves updating or statusing the activity or task utilizing one of two methods: (1) update the remaining time to complete (remaining duration) and the scheduling software will then automatically update the schedule percent complete or (2) update the schedule percent complete and allow the scheduling software to calculate the time remaining (remaining duration) to complete. Either method will use the following formula: Percent of Duration Completed = (Actual Duration / Total Duration) X 100.

13.3.6.5 Task/Activity and Milestone Descriptions. These are descriptive titles that are concise, complete, and clearly identify the work effort being accomplished. Abbreviations may be used to shorten the descriptive titles.

13.3.6.6 Task/Activity Codes and Data Dictionary. A list of field definitions and code structures. This list shall be provided to the procuring activity.

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13.3.6.7 Relationship/Dependency. These identify how predecessor and successor tasks/activities and milestones are logically linked. Relationships, also called network logic, are modeled in four ways:

13.3.6.7.1 Finish to Start (FS). A predecessor task/activity or milestone that must finish before a succeeding task/activity or milestone can start. FS relationships shall be used whenever possible.

13.3.6.7.2 Start to Start (SS). A predecessor task/activity or milestone that must start before a succeeding task/activity or milestone can start.

13.3.6.7.3 Finish to Finish (FF). A predecessor task/activity or milestone that must finish before a succeeding task/activity or milestone can finish.

13.3.6.7.4 Start to Finish (SF). A predecessor task/activity or milestone that must start before a succeeding task/activity or milestone can finish.

13.3.6.8 Total Float/Slack. The amount of time a task/activity or milestone can slip before it delays the contract or project finish date.

13.3.6.9 Free Float/Slack. The amount of time a task/activity or milestone can slip before it delays any of its successor tasks/activities or milestones

13.3.6.10 Lag. An interval of time that must occur between a predecessor and successor task/activity or milestone. Since negative time is not demonstrable, negative lag is not encouraged. (Note: Lag should not be used to manipulate float/slack or constrain schedule.)

13.3.6.11 Early Start (ES). The earliest start date a task/activity or milestone can begin the precedence relationships. A computer-calculated date.

13.3.6.12 Early Finish (EF). The earliest finish date a task/activity or milestone can end. A computer-calculated date.

13.3.6.13 Late Start (LS). The latest start date a task/activity or milestone can start without delaying the contract or project target completion date. A computer-calculated date.

13.3.6.14 Late Finish (LF). The latest date a task/activity or milestone can finish without delaying the contract or project target completion date. A computer-calculated date.

13.3.6.15 Critical Path. A sequence of discrete tasks/activities in the network that has the longest total duration through the contract or project. Discrete tasks/activities along the critical path have the least amount of float/slack. The critical path and near-critical paths (reporting requirements for near-critical paths shall be a total float of 5 days or less) are calculated by the scheduling software application. Note: Total float is the amount of time that an activity can be lengthened or slipped without delaying the project completion or mandatory critical milestone completion, assuming that all other activities are done in their normal time. The guidelines for critical path and near-critical path reporting are as follows:

13.3.6.15.1 Methodology. The IMS software application computes a critical path and near-critical paths based on precedence relationships, lag times, durations, constraints, and status. Artificial constraints and incorrect, incomplete, or overly constrained logic shall be avoided

because they can skew the critical path and near-critical paths.

13.3.6.15.2 Identification. The critical path shall be easily identified.

13.3.6.16 Constraints. Limits applied to network start and finish dates (e.g., 'finish no later than'). (Note: Certain types of constraints should be used judiciously because they may impact or distort the network critical path.)

13.3.6.17 Current Schedule. The IMS reflects the current status and forecast. It includes forecasted starts and finishes for all remaining tasks/activities and milestones. Significant variances to the baseline schedule shall be explained in the periodic analysis. Thresholds for reporting shall be specified in the Performance Assessment Plan. The Performance Assessment Plan shall be delivered in accordance with DRD CEV-M-002.

13.3.6.18 Baseline Schedule. Baseline dates in the IMS shall be consistent with the baseline dates in the PMB for all work packages, planning packages, and control accounts (if applicable). The guidelines for maintaining the baseline schedule are as follows:

13.3.6.18.1 Schedule Changes. Changes to the schedule shall be baselined when incorporated into the schedule.

13.3.6.18.2 Baseline Schedule Changes. Changes to the baseline schedule shall be made in accordance with the Contractor's EVM process. Any movement of contractual milestones in the baseline schedule requires the approval of the procuring activity.

13.3.6.19 Schedule Progress. The IMS shall reflect actual progress and maintain accurate start and finish dates for all tasks/activities and milestones. The guidelines for reflecting schedule progress are as follows:

13.3.6.19.1 Actual Start and Finish Dates. Actual start and actual finish dates shall be recorded in the IMS. Actual start and actual finish dates, as recorded, shall not be later than the status date.

13.3.6.19.2 Progress Line. The progress line depicted in a Gantt chart shall be applied to the current schedule.

13.3.6.20 Retention of Data for Completed Tasks/Activities. Historical performance on completed tasks/activities shall be maintained electronically for analytical use. Data to be retained includes logic, actual and baseline durations, actual and baseline start and finish dates, and the three-point estimates that were used before the task/activity started. The retention of the IMS data shall be identified in the Contractor Data Management Plan.

13.3.6.21 External Dependencies. The IMS shall identify significant external dependencies that involve a relationship or interface with external organizations, including all Government furnished items (e.g., decisions, facilities, equipment, information, data, etc.). The determination of significant shall be defined and documented, and agreed to by NASA. The required or expected delivery dates shall also be identified in the IMS.

13.3.6.22 Schedule Margin. A management method for accommodating schedule contingencies. It is a designated buffer and shall be identified separately and considered part of the baseline. Schedule

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margin is the difference between contractual milestone date(s) and the Contractor's planned date(s) of accomplishment.

13.3.6.23 Schedule Risk Assessment. A schedule risk assessment predicts the probability of project completion by contractual dates. Three-point estimates shall be developed for remaining durations of remaining tasks/activities that meet any of the following criteria: (1) critical path tasks/activities, (2) near-critical path tasks/activities (as specified in the CDRL), (3) moderate to high risk tasks/activities in the project's risk management plan. These estimates include the most likely, best case, and worst case durations. They are used by the Contractor to perform a probability analysis of key contract completion dates. The criteria for estimated best and worst case durations shall be applied consistently across the entire schedule and documented in the Contractor's schedule notes and management plan. The guidelines for estimates are as follows:

13.3.6.23.1 Most Likely Estimate. Schedule durations based on the most likely estimates.

13.3.6.23.2 Best/Worst Case Estimates. Best and worst case assumptions shall be disclosed. The Contractor schedule risk assessment shall explain changes to the critical path, margin erosion, and mitigation plans. It shall be incorporated into the Contractor's project risk management process. The schedule risk assessment shall be submitted as specified in the CDRL and prior to the Integrated Baseline Review. The risk analysis may be performed within the IMS or within a separate risk tool as appropriate based on the capability of the automated scheduling tool.

13.3.6.24 User Defined Fields. All user defined fields in the IMS shall be identified by providing a mapping of all fields used in the scheduling software application.

13.3.5.25 Reserved Fields. NASA may reserve some fields and/or require the Contractor to use certain fields for specific information. The requirement for reserved fields shall be specified in the CDRL.

13.3.6.26 Calendar. The arrangement of normal working days, together with non-working days, such as holidays, as well as special work days (i.e., overtime periods) used to determine dates on which project work will be completed.

13.3.7. Monthly Analysis. Monthly analysis is a monthly assessment of schedule progress to date and includes changes to schedule assumptions, variances to the baseline schedule, causes for the variances, potential impacts, and recommended corrective actions to minimize schedule delays. The analysis shall also identify potential problems and an assessment of the critical path and near-critical paths. Thresholds for reporting significant variances to the baseline schedule and near-critical paths shall be specified in the CDRL. If a CPR Format 5 is required, the monthly analysis shall be submitted to the procuring activity prior to or concurrently with the CPR Format 5.

13.3.8. Format for the Cost Performance Report. Use the relevant DD Forms as listed above. All formats shall be submitted electronically in accordance with the following requirements. All formats shall be in a readable digital format (e.g., PDF files are not acceptable). The American National Standards Institute (ANSI) X12 standard (839 transaction set), the United Nations Electronic Data Interchange for Administration, Commerce and Transport (UN/EDIFACT) standard (PROCST message), the XML equivalent or any other equivalent or better electronic

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format shall be used to submit data electronically to the procuring activity. Contractor formats may be substituted whenever they contain all of the required data elements at the specified reporting levels and are compliant with the X12 standard, XML schema, or equivalent. On-line access to the data may be provided to augment formal CPR submission. (Note: Until the ANSI X12/XML standards are redefined to incorporate the changes to the forms, the new data elements shall be reported in Format 5.) The final decision of the acceptable format shall be made by the NASA COTR.

13.3.9. Content. The CPR shall contain the following:

13.3.9.1. Heading Information - Formats 1 - 5. Preparation instructions for Heading Information (Blocks 1 through 4) apply to Formats 1 through 5.

13.3.9.1.1. Contractor. Enter in Block 1.a the Contractor's name and division (if applicable). Enter in Block 1.b the facility location and mailing address of the reporting contractor.

13.3.9.1.2. Contract. Enter the contract name in Block 2.a, the contract number (and the applicable Contract Line Item Number(s) (CLINs)) in Block 2.b, the contract type in Block 2.c, and the contract share ratio (if applicable) in Block 2.d.

13.3.9.1.3. Project. Enter in Block 3.a the project name, number, acronym, type, model, and series, or other designation of the prime item(s) purchased under the contract. Indicate the project phase (development, production, etc.) in Block 3.b. Indicate whether the Contractor's EVMS has been accepted by NASA and the date of the acceptance.

13.3.9.1.4. Report Period. Enter the beginning date in Block 4.a and the ending date in Block 4.b of the period covered by the report.

13.3.9.1.5. Security Classification. Enter the appropriate security classification at the top and bottom of each page.

13.3.9.1.6. Dollars in \_ (to be filled in by Offeror) \_\_\_\_\_. If reported dollar amounts are in thousands, millions, or billions, enter the factor at the top of each page.

13.3.9.2. Format 1 - Work Breakdown Structure. Submission of Format 1 using a product-oriented WBS is mandatory and shall be in accordance with the Center WBS standard. If there are deviations, a mapping shall be provided.

13.3.9.2.1. Contract Data.

13.3.9.2.1.1. Quantity. Enter in Block 5.a the number of principal items to be procured on this contract.

13.3.9.2.1.2. Negotiated Cost. Enter in Block 5.b the dollar value (excluding fee or profit) on which contractual agreement has been reached as of the cutoff date of the report. For an incentive contract, enter the definitized contract target cost. Amounts for changes shall not be included in this item until they have been priced and incorporated in the contract through contract change order or supplemental agreement. For a cost plus fixed fee, award fee, or incentive fee contract, enter the estimated cost negotiated. Changes to the estimated cost shall consist only of estimated amounts for changes in the contract scope of work, not for cost growth ('overrun') above the original estimated cost.

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13.3.9.2.1.3. Estimated Cost of Authorized, Unpriced Work. Enter in Block 5.c the amount (excluding fee or profit) estimated for that work for which written authorization has been received, but for which definitized contract prices have not been incorporated in the contract through contract change order or supplemental agreement.

13.3.9.2.1.4. Target Profit/Fee. Enter in Block 5.d the fee or percentage of profit that shall apply if the negotiated cost of the contract is met. (See 13.3.9.2.1.2 above.)

13.3.9.2.1.5. Target Price. Enter in Block 5.e the target price (negotiated contract cost plus profit/fee) applicable to the definitized contract effort.

13.3.9.2.1.6. Estimated Price. Based on the most likely estimate of cost at completion for all authorized contract work and the appropriate profit/fee, incentive, and cost sharing provisions, enter in Block 5.f the estimated final contract price (total estimated cost to the Government). This number shall be based on the most likely management EAC in Block 6.c.1 and normally will change whenever the management estimate or the contract is revised.

13.3.9.2.1.7. Contract Ceiling. Enter in Block 5.g the contract ceiling price applicable to the definitized effort.

13.3.9.2.1.8. Estimated Contract Ceiling. Enter in Block 5.h the estimated ceiling price applicable to all authorized contract effort including both definitized and undefinitized effort.

13.3.9.2.1.9. Over Target Baseline/Over Target Schedule. Enter in Block 5.i the date the last over target baseline or over target schedule was implemented (if applicable).

13.3.9.2.2. Estimated Cost at Completion. These blocks shall present the Contractor's range of estimated costs at completion. The range of estimates is intended to allow contractor management flexibility to express possible cost outcomes. Contractors shall provide the most accurate Estimates at Completion (EACs) possible through project-level assessments of factors that may affect the cost, schedule, or technical outcome of the contract. Such project-level assessments shall include consideration of known or anticipated risk areas, and planned risk reductions or cost containment measures. EACs shall be reported without regard to contract ceiling.

13.3.9.2.2.1. Management Estimate at Completion - Best Case. Enter in Block 6.a.1 the Contractor's best case EAC. The best case estimate is the one that results in the lowest cost to NASA. This estimate shall be based on the outcome of the most favorable set of circumstances. If this estimate is different from the most likely EAC (Block 6.c.1), the assumptions, conditions, and methodology underlying this estimate shall be explained briefly in Format 5. This estimate is for informational purposes only; it is not an official company estimate. There is no requirement for the Contractor to prepare and maintain backup data beyond the explanation provided in Format 5.

13.3.9.2.2.2. Management Estimate at Completion - Worst Case. Enter in Block 6.b.1 the Contractor's worst case EAC. The worst case estimate is the one that results in the highest cost to NASA. This estimate shall be based on the outcome of the least favorable set of circumstances. If this estimate is different from the most likely EAC (Block 6.c.1), the assumptions, conditions, and methodology underlying this estimate shall



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be explained briefly in Format 5. This estimate is for informational purposes only; it is not an official company estimate. There is no requirement for the Contractor to prepare and maintain backup data beyond the explanation provided in Format 5.

13.3.9.2.2.3 Management Estimate at Completion - Most Likely. Enter in Block 6.c.1 the Contractor's most likely EAC. This estimate is the contractor's official contract EAC and, as such, takes precedence over the estimates presented in Column (15) of Formats 1 and 2 and Blocks 6.a.1 and 6.b.1. This EAC is the value that the Contractor's management believes is the most likely outcome based on a knowledgeable estimate of all authorized work, known risks, and probable future conditions. This value need not agree with the total of Column (15) (Block 8.e). However, any difference shall be explained in Format 5 in such terms as risk, use of Management Reserve (MR), or higher management knowledge of current or future contract conditions. The assumptions, conditions, and methodology underlying this estimate shall be explained briefly in Format 5. This EAC need not agree with EACs contained in the Contractor's internal data, but must be reconcilable to them. The most likely EAC shall also be reconcilable to the Contractor's latest statement of funds required as reported in the CFSR, or its equivalent.

13.3.9.2.2.4. Contract Budget Base. Enter in Block 6.c.2 the total of negotiated cost (Block 5.b) and estimated cost of authorized, unpriced work (Block 5.c).

13.3.9.2.2.5. Variance. Enter in Block 6.c.3 the contract Budget Base (Block 6.c.2) minus the most likely estimate at complete (Block 6.c.1). This value shall be explained in Format 5 according to applicable contractual requirements.

13.3.9.2.3. Authorized Contractor Representative. Enter in Block 7.a the name of the authorized person (project manager or higher level designee) signing the report. Enter that person's title in Block 7.b. The authorized person shall sign in Block 7.c. Enter the date signed in Block 7.d. Electronic signatures are encouraged.

13.3.9.2.4. Performance Data.

13.3.9.2.4.1. Column (1) -Work Breakdown Structure Element. Enter in Column (1) of Block 8.a the noun description of the CWBS items for which cost information is being reported. CWBS elements and levels reported shall be those specified in the contract. (See d.1 above.)

13.3.9.2.4.2. Cost of Money. Enter in Columns (2) through (16) of Block 8.b the Facilities Capital Cost of Money applicable to the contract.

13.3.9.2.4.3. General and Administrative. Enter in Columns (2) through (16) of Block 8.c the appropriate General and Administrative (G&A) costs. If G&A has been included in the total costs reported in Block 8.a above, G&A shall be shown as a non-add entry on this line with an appropriate notation. However, if these contracts require CCDRs, the Contractor must report costs without G&A for CWBS elements reported in Block 8.a if the Government requests such information on an exception basis. If a G&A classification is not used, no entry shall be made other than an appropriate notation to that effect.

13.3.9.2.4.4. Undistributed Budget (UB). Enter the amount of budget applicable to contract effort that has not yet been identified to CWBS elements at or below the reporting level. For example, if contract changes were authorized late in the reporting period, they should have received a total budget; however, assignment of work and allocation of

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budgets to individual CWBS elements may not have been accomplished as of the Contractor's accounting period cutoff date. Budgets that can be identified to CWBS elements at or below the specified reporting level shall be included in the total budgets shown for the CWBS elements in Block 8.a and shall not be shown as UB. Enter in Column (15) of Block 8.d the EAC for the scope of work represented by the UB in Column (14) of Block 8.d. Enter in Column (16) of Block 8.d the variance, if any, and fully explain it in Format 5. The reason(s) for UB shall be fully explained in Format 5.

13.3.9.2.4.4.1. Use of Undistributed Budget. UB is used to accommodate temporary situations where time constraints prevent adequate budget planning or where contract effort can only be defined in very general terms. UB shall not be used as a substitute for adequate contract planning. Formal budgets shall be allocated to contract effort and responsible organizations at the earliest possible time, preferably within the next reporting period.

13.3.9.2.4.5. Subtotal (Performance Measurement Baseline). In Columns (2) through (16) of Blocks 8.a through 8.e, enter the sum of the costs and budgets for direct, indirect, cost of money, and G&A. This subtotal represents the dollars in the allocated budget (less MR), which is the Performance Measurement Baseline (PMB) against which performance is measured.

13.3.9.2.4.6. Management Reserve (MR). MR is an amount of the overall contract budget withheld for management control purposes and is held for project unknowns (realized risks on authorized work scope). Reserve is held for future needs and shall not be used to offset cumulative cost variances. It shall not be eliminated from contract prices by the Government during subsequent negotiations nor used to absorb the cost of contract changes. In Column (14) of Block 8.f enter the total amount of budget identified as MR as of the end of the current reporting period. The amounts shown as MR in Formats 1, 2, and 3 should agree. Amounts of MR applied to CWBS elements during the reporting period shall be listed in Block 6.b of Format 3 and explained in Format 5.

13.3.9.2.4.6.1. Negative Management Reserve. Negative entries shall not be made in Management Reserve (Column (14) of Block 8.f). There is no such thing as 'negative MR.' If the contract is budgeted in excess of the Contract Budget Base (the negotiated contract cost plus the estimated cost for authorized, unpriced work), the provisions applicable to formal reprogramming and the instructions in paragraphs 13.3.9.2.5.1, 13.3.9.2.6.6., 13.3.9.2.6.7., and 13.3.9.4.1.7 apply.

13.3.9.2.4.7. Total. Enter the sum of all direct, indirect, cost of money, and G&A costs, and UB and MR (if applicable) in Columns (2) through (14) of Block 8.g. The Total lines of Format 1 (Block 8.g) and Format 2 (Block 5.g) should agree. The total of Column (14), Block 8.g, should equal the Total Allocated Budget shown in Block 5.f on Format 3.

#### 13.3.9.2.5 Reconciliation to Contract Budget Base.

13.3.9.2.5.1. Formal Reprogramming. In exceptional cases, the Contractor, with the approval of the Government, may establish performance measurement budgets that exceed the Contract Budget Base. This process is called formal reprogramming. The Contractor and the Government shall agree on how the results of a formal reprogramming will be reported in the CPR before the formal reprogramming is initiated. This agreement and any other pertinent details on the reporting of the formal reprogramming shall be included in Format 5. Blocks 9.a and 9.b are used to reconcile the higher performance measurement budgets, also

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called an 'Over Target Baseline,' to the Contract Budget Base. (See 13.3.9.2.6.6., 13.3.9.2.6.7., 13.3.9.4.1.7. and 13.3.9.6.5 below for more information on reporting Over Target Baselines (Formal Reprogramming).)

13.3.9.2.5.2. Variance Adjustment. In a formal reprogramming (Over Target Baseline), the Contractor may: (1) apply the additional budget to completed work, thereby eliminating some or all of the existing cost or schedule variances, (2) apply the additional budget to remaining work, (3) apply some of the additional budget to completed work and some to remaining work, and/or (4) apply some of the additional budget to MR. If the Contractor uses a portion of the additional budget to eliminate variances applicable to completed work, the total adjustments made to the cost and schedule variances shall be shown in Columns (10) and (11) of Block 9.a. The total cost variance adjustment entered in Column (11) of Block 9.a should be the sum of the individual cost variance adjustments shown in Column (12) of Block 8.g.

13.3.9.2.5.3. Total Contract Variance. In Columns (10) and (11) of Block 9.b, enter the sum of the cost and schedule variances shown on the Total line (Block 8.g) and on the Variance Adjustment line (Block 9.a). In Column (14) enter the Contract Budget Base from Block 6.c.2. In Column (15) enter the management EAC from Block 6.c.1. In Column (16) of Block 9.b enter the difference between Columns (14) and (15) of Block 9.b.

13.3.9.2.6. Columns (2) Through (16). Since compliance with the ANSI/EIA-748 (current version in effect at time of contract award) is contractually required, the data in Columns (2) through (16) shall reflect the output of the contractor's ANSI/EIA-748 compliant integrated management system.

13.3.9.2.6.1. Column (2) and Column (7) - Budgeted Cost - Work Scheduled. For the time period indicated, enter the Budgeted Cost for Work Scheduled (BCWS) in these columns.

13.3.9.2.6.2. Column (3) and Column (8) - Budgeted Cost - Work Performed. For the time period indicated, enter the Budgeted Cost for Work Performed (BCWP) in these columns.

13.3.9.2.6.3. Column (4) and Column (9) - Actual Cost - Work Performed. For the time period indicated, enter the Actual Cost of Work Performed (ACWP) without regard to ceiling. In all cases, costs and budgets shall be reported on a comparable basis.

13.3.9.2.6.4. Column (5) and Column (10) - Variance - Schedule (i.e., accomplishment). For the time period indicated, these columns reflect the differences between BCWS and BCWP. For the current period column, Column (5) (schedule variance) is derived by subtracting Column (2) (BCWS) from Column (3) (BCWP). For the cumulative to date column, Column (10) (schedule variance) is derived by subtracting Column (7) (BCWS) from Column (8) (BCWP). A positive number in Column (5) and Column (10) indicates a favorable variance. A negative number (indicated by parentheses) indicates an unfavorable variance. Significant variances as specified in the contract shall be fully explained in Format 5. If the contract does not specify variance analysis thresholds, the Contractor shall provide appropriate variance analyses.

13.3.9.2.6.5. Column (6) and Column (11) - Variance - Cost. For the time period indicated, these columns reflect the difference between BCWP and ACWP. For the current period column, Column (6) (cost variance) is derived by subtracting Column (4) (ACWP) from Column (3) (BCWP). For the cumulative to date column, Column (11) (cost variance) is derived by

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subtracting Column (9) (ACWP) from Column (8) (BCWP). A positive value indicates a favorable variance. A negative value (indicated by parentheses) indicates an unfavorable variance. Significant variances as specified in the contract shall be fully explained in Format 5. Since the contract does not specify variance analysis thresholds, the contractor shall provide appropriate variance analyses

13.3.9.2.6.6. Column (12a) and Column (12b) Reprogramming Adjustments - Cost Variance and Schedule Variance. Formal reprogramming (Over Target Baseline) results in budget allocations in excess of the Contract Budget Base and, in some instances, adjustments to previously reported variances. If previously reported variances are being adjusted, the adjustment applicable to each reporting line item affected shall be entered in Column (12a) if for a cost variance and Column (12b) if for a schedule variance. The total of Column (12a) and Column (12b) should equal the amount shown on the Variance Adjustment line (Block 9.a) in Column (10) and Column (11).

13.3.9.2.6.7. Column (13) Reprogramming Adjustments - Budget. Enter the total amounts added to the budget for each reporting line item as the result of formal reprogramming (Over Target Baseline). The amounts shown shall consist of the sum of the budgets used to adjust cost variances (Column (12)) plus the additional budget added to the CWBS element for remaining work. Enter the amount of budget added to MR in the space provided on the Management Reserve line (Block 8.f of Column (13)). The total of Column (13) should equal the budget amount by which the Total Allocated Budget exceeds the Contract Budget Base as shown in Block 5.g of Format 3. An explanation of the reprogramming shall be provided in Format 5.

13.3.9.2.6.7.1. Formal Reprogramming Reporting. Columns (12) and (13) are intended for use only in situations involving formal reprogramming (Over Target Baseline). Internal replanning actions within the Contract Budget Base do not require entries in these columns. Where contractors are submitting CPR data directly from automated systems, the addition of Columns (12) and (13) as shown may not be practical due to computer reprogramming problems or space limitations. In such cases, the information shall be provided in Format 5. Contractors shall not be required to abandon or modify existing automated reporting systems to include Columns (12) and (13) if significant costs will be associated with such change. Nor shall contractors be required to prepare the report manually solely to include this information

13.3.9.2.6.7.2. Formal Reprogramming Timeliness. Formal reprogramming (Over Target Baseline) can be a significant undertaking that may require more than a month to implement. To preclude a disruption of management visibility caused by a reporting hiatus, formal reprogramming shall be implemented expeditiously. If a reporting hiatus is needed, the Contractor and the Government shall agree on the date and duration of the hiatus before the formal reprogramming is initiated.

13.3.9.2.6.8. Column (14) - At Completion - Budgeted. Enter the budgeted cost at completion for the items listed in Column (1). This entry shall consist of the sum of the original budgets plus or minus budget changes resulting from contract changes, internal replanning, and application of MR. The total (Block 8.g) should equal the Total Allocated Budget shown in Block 5.f on Format 3.

13.3.9.2.6.9. Column (15) - At Completion - Estimated. Enter the latest revised estimate of cost at completion including estimated overrun/underrun for all authorized work. If the subtotal (Block 8.e) does not agree with the most likely management EAC (Block 6.c.1), the

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difference shall be explained in Format 5.

13.3.9.2.6.10. Column (16) - At Completion - Variance. Enter the difference between the Budgeted - At Completion (Column (14)) and the Estimated - At Completion (Column (15)) by subtracting Column (15) from Column (14). A negative value (indicated by parentheses) reflects an unfavorable variance. Significant variances as specified in the contract shall be fully explained in Format 5. If the contract does not specify variance analysis thresholds, the contractor shall provide appropriate variance analyses.

13.3.9.3. Format 2 - Organizational Categories.

13.3.9.3.1. Performance Data.

13.3.9.3.1.1. Column (1) - Organizational Category. In Block 5.a list the organizational categories that reflect the contractor's internal management structure. The level of detail to be reported normally will be limited to the organizational level immediately under the operating head of the facility. The contractor may report this information according to its own internal management structure. If the contractor is organized by product teams, this format may not be needed because it may resemble Format 1.

13.3.9.3.1.2. Cost of Money. Enter in Columns (2) through (16) of Block 5.b the Facilities Capital Cost of Money applicable to the contract.

13.3.9.3.1.3. General and Administrative. Enter in Columns (2) through (16) of Block 5.c the appropriate G&A costs. If G&A has been included in the total costs reported in Block 5.a above, G&A shall be shown as a non-add entry on this line with an appropriate notation. If a G&A classification is not used, no entry shall be made other than an appropriate notation to that effect.

13.3.9.3.1.4. Undistributed Budget. Enter in Column (14) of Block 5.d the budget applicable to contract effort that cannot be planned in sufficient detail to be assigned to a responsible organizational area at the reporting level. The amount shown on this format may exceed the amount shown as UB on Format 1 if budget is identified to a task at or below the CWBS reporting level but organizational identification has not been made; or may be less than the amount on Format 1 where budgets have been assigned to organizations but not to CWBS elements. Enter in Column (15) of Block 5.d the EAC for the scope of work represented by the UB in Column (14) of Block 5.d. Enter in Column (16) of Block 5.d the variance, if any, and fully explain it in Format 5.

13.3.9.3.1.5. Subtotal (Performance Measurement Baseline). Enter the sum of the direct, indirect, cost of money, and G&A costs and budgets in Columns (2) through (16) of Blocks 5.a through 5.e.

13.3.9.3.1.6. Management Reserve. In Column (14) of Block 5.f enter the amount of budget identified as MR. The MR entry should agree with the amounts shown in Formats 1 and 3.

13.3.9.3.1.7. Total. Enter the sum of all direct, indirect, cost of money, and G&A costs and budgets, UB, and MR (if applicable) in Columns (2) through (14) of Block 5.g. The totals on this page should equal the Total line on Format 1. The total of Column (14) should equal the Total Allocated Budget shown in Block 5.f on Format 3.

13.3.9.3.2. Columns (2) Through (16). The instructions applicable to these columns are the same as the instructions for corresponding columns

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on Format 1.

13.3.9.4. Format 3 - Baseline.

13.3.9.4.1. Contract Data.

13.3.9.4.1.1. Original Negotiated Cost. Enter in Block 5.a the dollar value (excluding fee or profit) negotiated in the original contract. For a cost plus fixed fee, incentive, or award fee contract, enter the estimated cost negotiated. For an incentive contract, enter the definitized contract target cost.

13.3.9.4.1.2. Negotiated Contract Changes. Enter in Block 5.b the cumulative cost (excluding fee or profit) applicable to definitized contract changes that have occurred since the beginning of the contract.

13.3.9.4.1.3. Current Negotiated Cost. Enter in Block 5.c the sum of Blocks 5.a and 5.b. The amount shown should equal the current dollar value (excluding fee or profit) on which contractual agreement has been reached and should be the same as the amount in Negotiated Cost (Block 5.b) on Format 1.

13.3.9.4.1.4. Estimated Cost of Authorized, Unpriced Work. Enter in Block 5.d the estimated cost (excluding fee or profit) for contract changes for which authorization has been received from the contracting officer, but for which contract prices have not been incorporated in the contract, as shown in Block 5.c of Format 1.

13.3.9.4.1.5. Contract Budget Base. Enter in Block 5.e the sum of Blocks 5.c and 5.d.

13.3.9.4.1.6. Total Allocated Budget. Enter in Block 5.f the sum of all budgets allocated to the performance of the contractual effort. The amount shown shall include all MR and UB. This amount should be the same as that shown on the Total line in Column (14) on Format 1 (Block 8.g) and Format 2 (Block 5.g).

13.3.9.4.1.7. Difference. Enter in Block 5.g the difference between Blocks 5.e and 5.f. In most cases, the amounts shown in Blocks 5.e and 5.f will be identical. If the amount shown in Block 5.f exceeds that shown in Block 5.e, it usually is an indication of a formal reprogramming (Over Target Baseline). The difference shall be explained in Format 5 at the time the negative value appears and subsequently for any changes in the difference between Contract Budget Base and the Total Allocated Budget.

13.3.9.4.1.8. Contract Start Date. Enter in Block 5.h the date the Contractor was authorized to start work on the contract, regardless of the date of contract definitization. (Note: Long-lead procurement efforts authorized under prior contracts are not to be considered.)

13.3.9.4.1.9. Contract Definitization Date. Enter in Block 5.i the date the contract was definitized.

13.3.9.4.1.10. Planned Completion Date. Enter in Block 5.j the completion date to which the budgets allocated in the PMB have been planned. This date represents the planned completion of all significant effort on the contract. The cost associated with the schedule from which this date is taken is the Total Allocated Budget (Block 5.f of Format 3).

13.3.9.4.1.10.1. Performance Measurement Schedule Inconsistent With Contractual Schedule. In exceptional cases, the Contractor may determine

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that the existing contract schedule cannot be achieved and no longer represents a reasonable basis for management control. With Government approval, the contractor may rephase its performance measurement schedule to new dates that exceed the contractual milestones, a condition known as 'Over Target Schedule.' These new dates are for performance measurement purposes only and do not represent an agreement to modify the contract terms and conditions.

13.3.9.4.1.10.2. Over Target Schedule Agreement. The Government and the Contractor shall agree on the new performance measurement schedule prior to reporting it in the CPR. The Contractor shall provide pertinent information in Format 5 on any schedule milestones that are inconsistent with contractual milestones, beginning the month the schedule is implemented and each month thereafter.

13.3.9.4.1.10.3. Indicators of a Performance Measurement Schedule Inconsistent With the Contractual Schedule. Formal reprogramming or internal replanning may result in performance measurement milestones that are inconsistent with the contractual milestones (Over Target Schedule). A difference between the planned completion date (Block 5.j) and the contract completion date (Block 5.k) usually indicates that some or all of the performance measurement milestones are inconsistent with the contractual milestones.

13.3.9.4.1.11. Contract Completion Date. Enter in Block 5.k the contract scheduled completion date in accordance with the latest contract modification. The cost associated with the schedule from which this date is taken is the Contract Budget Base (Block 5.e of Format 3).

13.3.9.4.1.12. Estimated Completion Date. Enter in Block 5.l the Contractor's latest revised estimated completion date. This date represents the estimated completion of all significant effort on the contract. The cost associated with the schedule from which this date is taken is the 'most likely' management EAC (Block 6.c 1 of Format 1).

13.3.9.4.2. Performance Data.

13.3.9.4.2.1. Column (1) -Performance Measurement Baseline (Beginning of Period). Enter in Block 6.a the time-phased PMB (including G&A) that existed at the beginning of the current reporting period. Most of the entries on this line (e.g., for Columns (4) through (9)) are taken directly from the PMB (End of Period) line on the previous report. For example, the number in Column (4) on the PMB (End of Period) line from the last report becomes the number in Column (3) on the PMB (Beginning of Period) line on this report. The number in Column (5) (End of Period) last report becomes Column (4) (Beginning of Period) on this report, etc. (if each of the two columns covers the same length of time)

13.3.9.4.2.2. Baseline Changes. In Block 6.b, list all significant baseline changes that have occurred during the reporting period. This listing shall include the contract changes and supplemental agreements authorized during the reporting period, allocations from MR and UB, and any significant rephasing of budgets. All significant authorized baseline changes shall be listed whether priced or unpriced.

13.3.9.4.2.3. Performance Measurement Baseline (End of Period). Enter in Block 6.c the time-phased PMB as it exists at the end of the reporting period. The difference between this line and the PMB (Beginning of Period) represents the effects of all significant changes, including the authorized changes, allocations of MR made during the period, and changes to time phasing due to internal replanning or formal reprogramming. The reasons for these changes shall be explained in Format 5

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13.3.9.4.2.4. Management Reserve. Enter in Block 7 the total amount of MR remaining as of the end of the reporting period. This value should agree with the amounts shown as MR in Formats 1 and 2.

13.3.9.4.2.5. Total. Enter in Column (16) of Block 8 the sum of Column (16) of Block 6.c (PMB (End of Period)) and Column (16) of Block 7 (Management Reserve). This amount should be the same as that shown on the Total line (Block 8.g) in Column (14) on Format 1.

13.3.9.4.3. Column (2) - BCWS - Cumulative To Date. On the PMB (Beginning of Period) line (Block 6.a), enter the cumulative BCWS as of the first day of the reporting period. This should be the same number reported as BCWS -Cumulative To Date on the Total line (Column (7) of Block 8.g) of Format 1 of the previous CPR. On the PMB (End of Period) line (Block 6.c), enter the cumulative BCWS as of the last day of the reporting period. This should be the same number reported as BCWS - Cumulative to Date on the Total line (Column (7) of Block 8.g) of Format 1 for this CPR.

13.3.9.4.4. Column (3) - BCWS For Report Period. On the PMB (Beginning of Period) line (Block 6.a), enter the BCWS planned for the reporting period. This should be the number in Column (4) on the PMB (End of Period) line (Block 6.c) on the previous CPR.

13.3.9.4.5. Columns (4) Through (14). Enter the names of each month for the contract period of performance in the headings of each of the Columns (4) through (9), and the names of the appropriate periods in the headings of each of the Columns (10) through (14) of Block 6. Columns beyond (14) may be added when necessary or desirable. In the PMB (Beginning of Period) line (Block 6.a), enter the BCWS projection reported in Format 3 of the previous CPR as PMB (End of Period) (Block 6.c). In the PMB (End of Period) line (Block 6.c) of this report, enter the projected BCWS by month for the next six months and for periodic increments (monthly, quarterly, or annually) thereafter for the remainder of the contract. The time phasing of each item listed in Column (1) of Block 6.b need not be shown in Columns (4) through (14). It is useful to show the time phasing of any baseline changes. (Note: For the purposes of illustration, Sample Format 3 has Columns (4) through (14) for reporting BCWS. The actual number of columns will vary from contract to contract.)

13.3.9.4.6. Column (15) - Undistributed Budget. On the PMB (Beginning of Period) line (Block 6.a), enter the number from Column (15) on the PMB (End of Period) line (Block 6.c) from the previous CPR. On the PMB (End of Period) line, enter the UB shown in Column (14) of Block 8.d on Format 1 of this report.

13.3.9.4.7. Column (16) - Total Budget. On the PMB (Beginning of Period) line (Block 6.a) enter the number from Column (16) on the PMB (End of Period) line (Block 6.c) from the previous CPR. In the section where baseline changes that occurred during the period are listed (Column (1) of Block 6.b), enter the amount of each of the changes listed. On the PMB (End of Period) line (Block 6.c), enter the sum of the amounts in the preceding columns on this line. On the Management Reserve line (Block 7), enter the amount of MR available at the end of the period. On the Total line (Block 8) enter the sum of the amounts in this column on the PMB (End of Period) line and the Management Reserve line. (Note: This should equal the amount in Block 5.f on this format and also the amount of the Total line in Column (14), Block 8.g, of Format 1.)

13.3.9.5. Format 4 - Staffing.



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13.3.9.5.1. Performance Data. For those organizational categories shown in Column (1) of Block 5, equivalent months shall be indicated for the current reporting period (Column (2)), cumulative through the current period (Column (3)), forecast to completion (Columns (4) through (14)), and at completion (Column (15)). Direct equivalent months shall be shown for each organizational category for the contract. An equivalent month is defined as the effort equal to that of one person for one month. Values shall be reported in whole numbers. (Note: Partial months, .5 and above, shall be rounded to 1; below .5 to 0.) When the Government and the contractor agree, staffing may be reported in equivalent days or hours.

13.3.9.5.1.1. Column (1) - Organizational Category. In Block 5, list the organizational categories that reflect the contractor's internal management structure. Format 4 categories may differ from those reported in Format 2. If the Government needs different categories in Formats 2 and 4, the Format 4 categories shall be addressed during negotiations. (See f.4 above.)

13.3.9.5.1.2. Total Direct. In Block 6, Columns (2) through (15) enter the sum of all direct equivalent months for the organizational categories shown in Column (1).

13.3.9.5.2. Column (2) - Actual - Current Period. Enter the actual equivalent months incurred during the current reporting period.

13.3.9.5.3. Column (3) - Actual End of Current Period (Cumulative). Enter the actual equivalent months incurred to date (cumulative) as of the end of the reporting period.

13.3.9.5.4. Columns (4) Through (14) - Forecast (Non-Cumulative). Enter the names of each month for the contract period of performance in the headings of each of the Columns (4) through (9), and the names of the appropriate periods in the headings of each of the Columns (10) through (14) of Block 5. Enter a staffing forecast by month for the next six months and for periodic increments (monthly, quarterly, or annually) thereafter for the remainder of the contract. The staffing forecast shall reflect the same staffing estimate used as the basis for the EAC in Column (15) on both Formats 1 and Format 2. (Note: For the purposes of illustration, Sample Format 4 has Columns (4) through (14) for reporting staffing forecast. The actual number of columns will vary from contract to contract.)

13.3.9.5.5. Column (15) - Forecast at Completion. Enter the estimate of equivalent months necessary for the total contract in Column (15) by organizational category. This estimate shall be consistent with the 'most likely' management EAC shown in Column (15) of Block 8.e of Format 1. Any significant change in the total number of equivalent months at completion of the contract (i.e., Column (15) Total) shall be explained in Format 5.

13.3.9.6. Format 5 - Explanations and Problem Analyses.

13.3.9.6.1. General. Format 5, Explanations and Problem Analyses, is a narrative report prepared to amplify and explain data in the other CPR formats. Format 5 shall normally address the following: (1) contractually required cost, schedule, and EAC variance analyses, (2) MR changes and usage, (3) UB contents, (4) differences between the best case, worst case, and most likely management EAC, if any, (5) the difference between the most likely management EAC and the estimate in Block 8.e of Column (15), if any, (6) significant differences between beginning of period PMB time phasing and end of period PMB time phasing in Format 3, (7) performance measurement milestones that are inconsistent

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with contractual milestones (Over Target Schedule), (8) formal reprogramming (Over Target Baseline) implementation details, and (9) significant staffing estimate changes in Format 4. Any other topic relevant to contract cost, schedule, or technical performance may be addressed in this format. The date(s) of the Integrated Baseline Review(s) may also be addressed in this format. Contractors may elect to attach subcontractor Format 5 reporting and cross reference this analysis in the Format 5 reporting submitted to the Government to gain time efficiencies and meet submission dates.

13.3.9.6.2. Total Contract. Provide a summary analysis that identifies significant problems affecting performance. Indicate corrective actions required, including Government action where applicable. Significant changes since the previous report shall be highlighted. Discuss any other issues affecting successful attainment of contract cost, schedule, or technical objectives that the Contractor deems significant or noteworthy. This section is brief, normally one page.

13.3.9.6.3. Cost and Schedule Variances. Explain all variances that exceed specified variance thresholds. Explanations of variances shall clearly identify the nature of the problem, significant reasons for cost or schedule variance, effect on the immediate task, impact on the total contract, and the corrective action taken or planned. Explanations of cost variances shall identify amounts attributable to rate changes separately from amounts applicable to hours worked; amounts attributable to material price changes separately from amounts applicable to material usage; and amounts attributable to overhead rate changes separately from amounts applicable to overhead base changes or changes in the overhead allocation basis. To reduce the volume of variance analysis explanations, the Contractor may refer to a prior CPR's variance analysis explanations if the explanation for the current CPR's variance has not changed significantly. The contractor shall classify and document all variances as either 'risk-driven cost & schedule growth' or 'externally-driven cost & schedule growth' (see below for definitions) in Format 5 as source information for the CADRe. The source of this information shall be at the Control Account level, however, the consolidation and customer reporting can be done at higher levels within the performing organization. 'Risk-Driven Cost & Schedule Growth' (RDCG & RDSG) is that cost and schedule growth caused by overruns and funded or unfunded changes, linked to technical risks identified in paragraph 7.c.1 above. 'Externally-Driven Cost & Schedule Growth' (EDCG & EDSG) is that cost and schedule growth caused by overruns and funded or unfunded changes, linked to external factors (e.g., requirements changes, technical enhancements not driven by risk, perturbations to budgets by external agents causing schedule changes, etc.) over which the contractor has little, if any, control. (NOTE: The EDCG & EDSG drivers shall be specifically identified in variance analysis reporting). Explanations of schedule variances and the impact on the contract shall be performed in parallel with the schedule analysis called out by the IMS DID.

13.3.9.6.3.1. Setting Variance Analysis Thresholds. In Format 5, the Government will require only that amount of variance analysis that satisfies its management information needs. Excessive variance analysis is burdensome and costly, and detracts from the CPR's usefulness, while too little information is equally undesirable.

13.3.9.6.4. Other Analyses. In addition to variance explanations, the following analyses are mandatory:

13.3.9.6.4.1. Management Estimate at Completion. If the best or worst case management EACs differ from the most likely estimate (Column (1) of Block 6 of Format 1), a brief explanation of the difference shall be

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provided. Also, if the most likely management EAC differs from the total entered in Column (15) of Format 1 or 2, the difference shall be explained. The explanations shall focus on such areas as a knowledgeable, realistic risk assessment; projected use of MR; estimate for UB; and higher management's knowledge of current or future contract conditions. The assumptions, conditions, and methodology underlying all management EACs shall be explained (See 13.3.9.2.2 to 13.3.9.2.2.3., 13.3.9.2.2.5, 13.3.9.2.6.9, and 13.3.9.2.6.10 above.) The reasons for significant shifts in time phasing of the EAC shall also be explained.

13.3.9.6.4.2. Undistributed Budget. Identify the effort to which the UB applies. Also, explain any variance between the UB and the estimate for UB in Formats 1 and 2. (See 13.3.9.2.4.4, and 13.3.9.3.1.4. above.)

13.3.9.6.4.3. Management Reserve Changes. Identify the sources and uses of MR changes during the reporting period. Identify the CWBS and organizational elements to which MR is applied, and the reasons for its application. (See 13.3.9.2.4.6. above.)

13.3.9.6.4.4. Baseline Changes. Explain reasons for significant shifts in time phasing of the PMB shown on Format 3. (See 13.3.9.4.2.3 above.)

13.3.9.6.4.5. Staffing Level Changes. Explain significant changes in the total staffing EAC shown on Format 4. Also, explain reasons for significant shifts in time phasing of planned staffing (See 13.3.9.5.5 above.)

13.3.9.6.5. Formal Reprogramming (Over Target Baseline). If the difference shown in Block 5.g on Format 3 becomes a negative value or changes in value, provide information on the following:

13.3.9.6.5.1. Authorization. Procuring activity authorization for the baseline change that resulted in negative value or change.

13.3.9.6.5.2. Reason. A discussion of the reason(s) for the change.

13.3.9.6.5.3. CPR Reporting. A discussion of how the change affected CPR reporting (i.e., amount allocated to MR, adjustments to cost or schedule variances, etc.). (See 13.3.9.4.1.7., 13.3.9.2.5.1., and 13.3.9.2.6.7. above.)

13.3.9.6.5.4. Schedule. Indicate whether the contract schedule was retained for performance measurement or was replaced with a schedule that exceeds the contractual schedule (Over Target Schedule).

13.3.9.6.5.5. Over Target Schedule. If a performance measurement schedule exceeding the contractual schedule (Over Target Schedule) has been implemented, provide a discussion of the pertinent information, such as authorization, reasons, and significant dates. (See 13.3.9.4.1.10.1 above.)

- 13.4 **FORMAT:** CPR formats shall be completed according to the instructions outlined in this DRD:

The IMS shall be created using a network capable scheduling software application. The IMS shall be delivered in native digital format (i.e., an electronic file produced by the Contractor's scheduling tool). The IMS shall be submitted electronically per Section J-2 2.3.2.1 and 3. The American National Standards Institute (ANSI) X12 standard (806 transaction set), the United Nations Electronic Data Interchange for Administration, Commerce and Transport (UN/EDIFACT) standard (PROTAP message), or the XML equivalent shall be used to submit data

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electronically to the procuring activity with on-line access to the data.

Those CPR Forms are reproduced at the end of this document and can also be found in the Bidder's Reference Library. Contractor formats shall be substituted for CPR formats whenever they contain all the required data elements at the specified reporting levels in a form suitable for NASA management use.

- 13.5 MAINTENANCE: Changes shall be incorporated by complete reissue.



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regardless of location.

b. Negative reports are required.

c. This reporting shall be completed in accordance with the NASA FAR Supplement (NFS) Subpart 1845.7101 and any supplemental guidance provided by the Contracting Officer. This reporting via NASA Form (NF) 1018 shall be submitted electronically using the Electronic Submission System (NESS) (<http://ness.gsfc.nasa.gov/>).

- 13.4 **FORMAT**: The monthly reports shall be electronically submitted using the Contractor-Held Asset Tracking System (CHATS) (<http://nasachats.gsfc.nasa.gov/>) using the format described in the CHATS user's manual.

The annual reporting via NASA Form (NF) 1018 shall be submitted electronically using the Electronic Submission System (NESS) (<http://ness.gsfc.nasa.gov/>).

- 13.5 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-D-001
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Flight Test Article (FTA) Definition
7. **DESCRIPTION/USE:**

The DRD describes the FTA design concept based on the objectives specified in SOW Tables 10.1 Launch Abort System Test Matrix and 10.2 Risk Reduction Flight Test Matrix and the Contractor flight test refinement. Based on the objectives identified in these tables, the DRD describes the FTA configuration proposed for each test. The DRD is a precursor to a more definitive FTA System Requirement document.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 10.1.1.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**

The FTA Configuration Definition DRD describes the architecture of each FTA, and for which flight test the FTA will be used. For each FTA it includes the following:

FTA Number.

Relationship of this FTA to tables 10.1 Launch Abort Flight Test Matrix and 10.2 Risk Reduction Flight Test Matrix (identify which test the FTA will be used).

Description of FTA proposed architecture:

  - o Launch Abort System (LAS) Concept
    - Passive vs Active
    - Hardware and software
    - Fidelity compared to Flight LAS (Concept, Proto Type, Flight)
  - o Structures and mechanisms
  - o Avionics and power scheme
  - o Guidance Navigation & Control scheme
  - o Integrated Vehicle Health Management (IVHM) scheme
  - o Estimated Software Lines of Code (SLOC) (new and reused)
  - o Redundancy scheme
  - o Instrumentation plan
  - o Ground support equipment requirements
  - o Reusability plans
  - o Spares plan.

For each area describe plans for the use of COTS hardware and Software as well as new hardware and software development.

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- 13.4 **FORMAT**: Documents shall be electronic format per Section J-2 2.3.2.1.
- 13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.



**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-D-002
3. **DATA TYPE:** 1
4. **DATE REVISED:** 12/20/2005
5. **PAGE:** 1
6. **TITLE:** Flight Test Article (FTA) System Requirements
7. **DESCRIPTION/USE:**  
For each FTA configuration, the DRD documents the FTA System functional and performance requirements necessary for the FTA to complete the flight test objectives.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 10 1.1.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
For each FTA configuration, the DRD documents the FTA System Functional and Performance requirements necessary for the FTA to complete the flight test objectives.

For each FTA configuration the DRD contains:

- 1.0 Scope
- 2.0 Documents
  - 2.1 Applicable Government Documents
  - 2.2 Applicable Non-government Publications
  - 2.3 Reference Documents
    - 2.3.01 Referenced Government Documents
    - 2.3.02 Referenced Non-government Publications
  - 2.4 Order of Precedence
- 3.0 Flight Test Article (FTA) System Requirements
  - 3.1 Definition
  - 3.2 Characteristics
    - 3.2.01 Test Objective Definition
    - 3.2.02 Function and Performance Requirements
    - 3.2.03 Physical Characteristics
    - 3.2.04 Reliability
    - 3.2.05 Maintainability
    - 3.2.06 Environmental Conditions
  - 3.3 Design and Construction
    - 3.3.01 Structural Design
    - 3.3.02 Materials
    - 3.3.03 Electromagnetic Environmental Effects
    - 3.3.04 Nameplates of Product Markings
    - 3.3.05 Workmanship
    - 3.3.06 Interchangeability

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- 3.3.07 Satety
- 3.3.08 Pyrotechnic
- 3.3.09 Security
- 3.4 Interfaces
  - 3.4.01 Standard Utilities Interface
  - 3.4.02 Pad Abort Launch Pad (LAS 1) Interface
  - 3.4.03 Abort Test Booster (LAS 2/3) Interface
  - 3.4.04 Crew Launch Vehicle (RRF1) Interface
  - 3.4.05 Command, Control, Communications, and Information (C3I) Interface
  - 3.4.06 Flight Test Range Interface
  - 3.4.07 Ground Operations Interface
  - 3.4.08 Flight Test Operations Interface
- 4.0 Verification
- 5.0 Packaging
- 6.0 Notes
- Appendix A FTA Design Goals and Objectives

- 13.4 **FORMAT**: Documents shall be electronic format per Section J-2 2.3 2.1.
- 13.5 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document is required.

1 PROGRAM: CEV 2 DRD NO.: CEV-D-003  
3 DATA TYPE: 1 4 DATE REVISED: 12/21/2005  
5 PAGE: 1  
6 TITLE: CEV [REDACTED]  
7 DESCRIPTION/USE:  
The DRD is a derivative of the CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD) tailored for the LAS4, RRF2 and RRF3 test flights. These tests will impose additional requirements above those required for a production CEV as well as eliminating requirements normally imposed on a production CEV. This document captures these differences in the CEV requirements.  
8 DISTRIBUTION: As determined by the Contracting Officer.  
9 INITIAL SUBMISSION: Per Data Requirements Matrix  
10 SUBMISSION FREQUENCY: Per Data Requirements Matrix  
11 REMARKS:  
12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 10.1.1.  
13 DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
13.2 APPLICABLE DOCUMENTS:  
13.3 CONTENTS:  
Tailor the CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD) as required to support a spacecraft build for [REDACTED] test flights.  
13.4 FORMAT: Documents shall be electronic format per Section J-2 2.3.2.1.  
13.5 MAINTENANCE: Changes shall be identified and complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-D-004
3. **DATA TYPE:** 2
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Flight Test Article (FTA) Engineering Design Data Book
7. **DESCRIPTION/USE:**  
Documents the FTA design in adequate detail for FTA integration with the Abort Test Booster (ATB), Test Range, Test Facility. Provides adequate technical documentation to satisfy safety reviews and test readiness reviews.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 10.1.2
13. **DATA PREPARATION INFORMATION:**
- 13.1. **SCOPE:**
- 13.2. **APPLICABLE DOCUMENTS:**
- 13.3. **CONTENTS:**
  1. Structures
    - (a) Contractor specified requirements and design and production standards for mechanical systems.
    - (b) All data and analyses necessary to support compliance to the contractor specified requirements and design and production standards for structures, both primary and secondary.
    - (c) Identification of lift points and description of lifting operations expected prior to the flight test and during post test recovery.
    - (d) All significant loads encountered for FTA service life, from manufacturing to end of service, static, dynamic, steady state, and transient loads shall be documented. Load combinations which occur simultaneously shall be defined.
  2. Mechanical Systems
    - (a) A detailed description of each mechanism, including a description of their functional requirements and operating environments.
    - (b) Any supporting data needed to completely understand the operation of the mechanism (such as all engineering drawings or diagrams). If these data are provided separately, high-level diagrams explaining the function of the system shall be included along with citations indicating where the detailed data can be found (e.g. drawing numbers, document numbers, etc.)
    - (c) Contractor specified requirements and design and production standards for mechanical systems.
    - (d) All data and analyses necessary to support compliance to the Contractor specified requirements and design and production standards for mechanical systems.
    - (e) A list of mandatory inspection points.

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(f) All mechanical component stress analysis reports showing margins of safety under all design load conditions.

### 3. Avionics and Power.

(a) Contractor specified requirements and design and production standards for Avionics and Power systems.

(b) All data and analyses necessary to support compliance to the Contractor specified requirements and design and production standards.

(c) Electrical Power System Circuit Protection and Isolation Plan. Plan and provisions for establishing, and maintaining electrical circuit protection for the FTA and FTA interfaces (including human safety) with ground maintenance/test facilities, Abort Test Booster, recovery, and refurbishment facilities (if applicable).

(d) Functional schematics

(e) Electrical Power System Grounding Analysis. Documents the electrical grounding design. Documents the analysis results of the electrical grounding.

(f) Electrical Power System Voltage Drop Analysis. Documents the analysis results using circuit resistance values based on wire size, wire length, temperature conditions, circuit element resistances, and varying load conditions. Documents voltage drops on all major circuits, loads, and interfaces at varying load conditions.

(g) Electrical Power System Transient Analyses. Documents the analysis results using normal and worst case subsystem and system interface conditions (voltage and bus transient and ripple), evaluates the design for proper performance and compatibility, and assures adequate margins between the source and the loads. Also documents the evaluation of power on/off switching transient generation for adverse (out-of-spec.) impacts to the interfacing bus.

(h) Electrical Power System Equipment Description and Performance Data. Comprehensive equipment documentation of the electrical power system that will provide detailed reference information for supporting Engineering and Operations including functional block diagrams.

### 4. Aerodynamic

(a) Vehicle stability and control assessment

(b) Vehicle interface loads and/or contact conditions

(c) Aerothermal loads assessment

(d) GN&C system failure modes analysis

(e) Backup/contingency flight modes assessment

(f) Flight test vehicle instrumentation predictions

(g) Navigation and flight control system error budget assessments

(h) TPS performance assessments

(i) Propulsion system performance assessment

(j) Aerosurface control effectiveness

(k) Flight phase specific targeting performance

(l) Range safety analyses

(m) Vehicle mass properties model, with uncertainties

(n) Vehicle geometry model, with uncertainties

(o) Aerodynamic database model; aerodynamic coefficient and loads methodology, with uncertainties

(p) Aerothermal database model; aeroheating model and methodology, with uncertainties

(q) GN&C system model and supporting documentation, with uncertainties: guidance algorithm description, navigation sensor characteristics, flight control actuator performance, and integrated system verification.

5. Decelerator systems, this DRD provides the pretest assumptions and analysis results in the following areas:

(a) Parachute stress analysis and safety margin calculations

(b) Energy modulator stripout calculations

(c) Pre-flight predictions that include:

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- 1) Trajectory predictions
  - 2) Timeline of events
  - 3) Deployment conditions, parachute inflation, parachute staging loads and timing assessment, extraction loads, sling loads, load sharing between slings, parachute descent rates, footprint of released parachutes, parachute stability, and landing impact
- 134 **FORMAI**: Contractor may divide into volumes/books if necessary. Models and code shall be submitted in their native format. Electronic format requirements per Section J-2 2.3.2.1 shall be followed as well.
- 135 **MAINTENANCE**: Changes shall be identified and complete re-issue of the document or other product is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-D-005
3. **DATA TYPE:** 1
4. **DATE REVISED:** 12/21/2005
5. **PAGE:** 1
6. **TITLE:** Flight Test Article (FTA) Validation and Verification Data Book
7. **DESCRIPTION/USE:**  
To provide the evidence and audit trail required by NASA to verify that the results from the validation and verification activities indicate that all requirements were met.
8. **DISTRIBUTION:** As determined by the Contracting Officer.
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix.
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix.
11. **REMARKS:**  
Verification requirements shall be individually defined for each component or subsystem considering its function, complexity, redundancy, design, and maintenance requirements
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 10.1.2.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Validation and Verification Data Book contains the elements of documentation required to establish that all requirements have been met by the integrated systems, hardware, and/or software.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
A Validation and Verification Data Book shall contain the following:
  1. A certification request summary spreadsheet, which contains the following:
    - (a) A listing of the relevant requirements and test documentation
    - (b) Operational information and relevant documentation
    - (c) Materials information
    - (d) Electrical information
    - (e) Electromagnetic compatibility information
    - (f) Temperature validation information
    - (g) Acceptance thermal/analysis information
    - (h) Structural validation information
    - (i) Pressure systems information
    - (j) Acceptance vibration information
    - (k) Performance verification information
    - (l) Waivers or requirements deviations
    - (m) Limited certification data
    - (n) Limited life data
    - (o) Software information
  2. Current version of the spacecraft system, module, subsystem, or component requirements document for the integrated system, hardware, or software that is being certified
  3. Current version of the master verification plan for the spacecraft system, module, subsystem, or component, including the verification

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matrix

4. Verification compliance report, including the verification matrix mapped to all verification data. This report shall include:
  - (a) Qualification report
  - (b) Acceptance report for the qualification unit or the first flight unit
  - (c) List of approved operational controls
  - (d) Structural integrity verification
  - (e) Verification tracking log
  - (f) Inspections reports
  - (g) Demonstrations reports
5. Risk information obtained from the FMEA and hazard analysis
6. Waivers, deviations and non-conformance reports
7. Discrepancy reports and problem closure reports relevant to certification
8. Limited life items list
9. Engineering drawings
10. Criticality assessment results
11. Software Version Description Document (VDD)

134 **FORMAT**: Electronic format per Section J-2 2.3.2 1.

135 **MAINTENANCE**: Contractor-proposed changes to this document shall be submitted to NASA for approval. Complete re-issue of the document is required.



1 PROGRAM: CEV 2 DRD NO.: CEV-D-006  
3 DATA TYPE: 2 4. DATE REVISED: 12/21/2005  
5. PAGE: 1  
6. TITLE: Flight Test Article (FTA) Ground Support Equipment (GSE) Design  
Data Book  
7 DESCRIPTION/USE:  
Documents the FTA GSE design including operational and maintenance  
procedures, maintenance parts list, and drawings. The comprehensive  
equipment documentation will provide detailed reference information to  
support Engineering and Operations throughout the life of the FTA GSE.  
8 DISTRIBUTION: As determined by the Contracting Officer.  
9 INITIAL SUBMISSION: Per Data Requirements Matrix  
10 SUBMISSION FREQUENCY: Per Data Requirements Matrix  
11 REMARKS:  
12 INTERRELATIONSHIP: Parent SOW Paragraph(s): 10 2  
13 DATA PREPARATION INFORMATION:  
13.1 SCOPE:  
The FTA GSE Design and Data Book documents the results of design,  
development, and proper operations of the FTA GSE. End-to-end functional  
schematics, drawings, and maintenance items parts lists shall be  
provided.  
13.2 APPLICABLE DOCUMENTS:  
NASA-STD-5005B: NASA Standard for Ground Support Equipment (and  
associated Applicable Document Children as specified in Attachment J-3,  
Applicable, Guidance, and Informational Documents List)  
13.3 CONTENTS:  
Documentation for support equipment and associated software shall  
include:  
1. Narrative description of the purpose and/or function of the support  
equipment item.  
2. Functional schematics of the support equipment item.  
3. Drawings of the support equipment item (in native file format).  
4. Physical dimensions of the item(s) including any required lifting  
weight, center of gravity, and ceiling hook height.  
5. Number and skill of personnel required to operate the support  
equipment.  
6. Hazard identification (e.g. classification of hazards, type of  
propellants, types of vents, types of purges, maximum fuel/oxidizer  
propellant quantities, types of ordnance, power voltages and  
frequencies, noise levels, RF radiation levels).  
7. Environmental requirements (e.g. temperature, humidity, particle  
counts, radio frequency shielding, noise attenuation, etc.).  
8. Power, grounding and lighting, including the use of uninterruptible  
power systems and supplies for ground operations activities.  
9. Communications, data networking systems.

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10. Special structural needs (e.g. vibration controls, etc.).
  11. Material handling requirements.
  12. Environmental pollution controls.
  13. Backup power and other backup or contingency requirements.
  14. References to any special studies and analyses that influenced the GSE design.
  15. Consideration of human engineering requirements.
  16. Operational and maintenance procedures
  17. Maintenance plan including items parts list, operation and maintenance requirements.
  18. Special operational requirements.
- 134 **FORMAT**: Electronic format per Section J-2 2.3.2.1.
- 135 **MAINTENANCE**: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the design data book document is required.

## DATA REQUIREMENTS DESCRIPTION (DRD)

2 DRD NO.: CEV-M-001

4. **DATE REVISED:** 12/20/2005

5. PAGE: 1

6. TITLE: CEV Prime Project Management Plan

7. **DESCRIPTION/USE:**

The CEV Prime Project Management Plan will describe the scope of the project and the implementation approach, including the systems and processes, to provide overall coordination of management activities under this contract. It describes the structure and environment within which the project operates

The CEV Prime Project Management Plan will also be used to integrate these activities into the broader NASA operational plans which utilize other government agencies and contractors. It will be used to identify Contractor management office and systems engineering structure for use by NASA personnel to identify reporting structures, to assist in evaluating performance measurement baseline status, and to ensure appropriate S&MA participation.

8. **DISTRIBUTION:** As determined by the Contracting Officer

9 INITIAL SUBMISSION: Per Data Requirements Matrix

10 **SUBMISSION FREQUENCY:** Per Data Requirements Matrix

## 11 REMARKS:

The following document(s) may be used as guidance:

- CXP-12000: NASA CEV Project Management Plan (PM-0001)

12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 1.1.1.

Referenced from SOW Paragraph(s): 2.1.1, 2.1.9

### 13. DATA PREPARATION INFORMATION:

13 1 **SCOPE:**

The Contractor shall provide information giving NASA insight into staffing, organizational structure, management approaches, and processes used across the entire CEV Project.

### 13.2 APPLICABLE DOCUMENTS:

CXP-00003: Constellation Architecture Common Glossary and Acronym List  
CXP-10001: Systems Requirements for the Crew Exploration Vehicle Element  
(CEV SRD)

13 3 **CONTENTS:**

The plan shall be in consonance with the SOW. The plan shall cover all aspects of project management for the Contractor CEV Project including, but not be limited to, the following:

- (a) Narrative and graphical descriptions of the management, technical, and business approaches used to accomplish and monitor contractual tasks, as well as the methods the contractor will employ to provide government insight, data accessibility, and/or deliverables.

(b) Interfaces between the Contractor, NASA centers, and other contractors or entities that are necessary and pertinent to the

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accomplishment of contractual tasks

(c) Including such things as data, analyses, equipment, and software deliverables, schedules, interfaces, and other technical/managerial interactions.

(d) Risk methodology and assessment of risks inherent in the management, technical, and business approaches including the process for incorporating lessons learned from previous applicable projects/programs.

(e) Narrative description of the contractor's management approach to defining processes, plans and procedures for project control and systems engineering including such items as logistics and integration of government furnished equipment/data and services.

(f) Narrative description of the contractor's acquisition strategy, including make/buy decisions and rationale.

(g) Planned reporting to NASA of performance to plan in preparation for major milestone reviews and regularly scheduled reviews.

(h) Narrative description of contractor controls applicable to any tasks and activities exceeding established cost or schedule plans, including requirements for providing recovery plans.

(i) Narrative description of the contractor's proposed scope and approach implementing cooperative relationships with associate contractors.

(j) Discuss your approach to data rights and intellectual property (IP) while minimizing the cost to the Government. Address what patents, copyrights, trademarks, and trade secrets will be delivered to the Government and the cost of such data/IP. Identify any limited data rights or restricted computer software issues, especially in the context of what the various corporate team members will provide. Explain how licensing agreements will be negotiated with vendors and how that data/IP will be treated, specifically identifying any requested special license agreements.

(k) Also as part of the Project Management Plan, the Contractor shall develop and implement a plan that periodically streamlines the CEV Project with the objectives of continually improving the efficiency and effectiveness of the project operation and of accelerating the schedule. The intent of this plan is to periodically examine the project processes, procedures and organization and identify improvements that provide greater responsiveness, and reduced schedule and cost. Some examples of items to be addressed include:

- o Maximum use of Contractor-based documentation and processes
- o Maximum use of IT resources to increase the productivity of each team member
- o Ensuring a very close Contractor/NASA working relationship for all team members, especially including the NASA contracting officer (CO) and contracting officer technical representative (COTR)
- o Reviewing the project documentation/deliverables to reflect the latest changes in the project and modify the data requirements list accordingly
- o A documented minimum content for each project data requirement description (DRD)
- o A documented minimum amount of reporting and statusing to NASA project, Agency and external forums.
- o A minimum set of requirements in the CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD).
- o A minimum set of project-wide metrics necessary to capture the progress and early identification of issues and problems. Update the metrics reported based on the life cycle phase and/or project management direction.
- o An aggressive effort to minimize requirements changes/additions over the life of the project.
- o Improving the change order review, approval and implementation process for those changes deemed mandatory.
- o A rapid but well-documented hardware and software modification process

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- o Measures to streamline overall project management, drawing on 'lessons learned' from small, efficient project teams.
- o Innovative teaming arrangements that results in a lower cost to the government..
- o New procedures that result in faster and better design, coordination and communication with no adverse affects on performance.
- o Expertise of the team
- o Collocation of the team

13.4 **FORMAT**: Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE**: Contractor proposed changes to document format shall be submitted to NASA for approval. Complete re-issue of the document is required.



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The Performance Assessment Plan shall consist of the following:

- (a) Description of the Contractor's approach and rationale for assessing performance, including reporting on the status of 'should' requirements in CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD) and the SOW.
- (b) Description of the methods the Contractor plans to use to assess performance, systems used, reporting mechanisms, and how the data will be used to improve future performance and adjust to changing requirements.
- (c) Description of management systems and processes used to implement the plan including the developing, timely gathering, compiling, maintaining, auditing, analyzing, reporting, and providing management review of performance metrics.
- (d) Description of the performance metrics including references to SOW paragraphs.
- (e) Description of the Technical Performance Parameters (TPPs) selected by the Contractor, and approved by NASA, for monitoring during the design and development. The Performance Assessment Plan shall identify a subset of the data included in the Margins Management Plan as TPPs. The TPPs will be proposed in the initial Performance Assessment Plan and 'selected' via approval of the Plan. Examples of TPPs are margins for mass properties, power allocation, volume, CPU utilization, bandwidth/throughput.
- (f) Description of any metrics used to address the performance toward IMP events, including the rationale for the development process and linkage between the metrics and the IMP events.

The metric description shall consist of at least the following for each metric:

- (a) Definition and description of the metric
- (b) Graphical representation
- (c) Algorithm (if calculated)
- (d) Assessment criteria for expected (standard) performance and excellent performance

The Performance Assessment Reports for metrics shall consist of the following:

- (a) Contractor's summary assessment ('metric score card') for all metrics
- (b) Status of all Technical Performance Parameters and their margin growth/loss and forecast
- (c) Metrics as described in the plan updated to reflect actual performance and quality during the period
- (d) Narrative performance assessment by month for each metric
- (e) Historical performance data
- (f) Index of any changes to metrics since the last period
- (g) Recommended action (i.e. performance improvement initiatives, lessons learned)

The Performance Management Review data packages support the quarterly management review of cost, schedule, and technical performance. Metrics for the initial submittal, including the Technical Performance Parameters (TPP), shall come from Contractor's approved Performance Assessment Plan. These metrics shall provide linkage to CEV Project-level metrics and Constellation Program-level metrics in the Integrated Collaborative Environment. The cost baseline is the Performance Measurement Baseline (PMB). The format provides a standardized approach for review materials.

The quarterly Performance Management Review package consists of:

- (a) Summary section
- (b) Pertinent performance/outcome based metrics (as requested by the PM, COTR)
- (c) Technical performance parameters (including margin growth/loss and forecast)

## Crew Exploration Vehicle - (CEV)

- (d) Stoplight status of fiscal year project cost, schedule, and technical performance
- (e) Summary status of fiscal year reserves, risks and opportunities, and earned value performance
- (f) Fiscal year cost and workforce summaries (including attrition metrics)
- (g) Cumulative variance explanations (to fiscal year plan) and end-of-year trend variance explanations (if threshold criteria exceeded)
- (h) SOW reconciliation (i.e., special projects, etc. that need to be accounted for) (as required)
- (i) Status of CXP-10001, Systems Requirements for the Crew Exploration Vehicle Element (CEV SRD) and SOW 'shoulds'
- (j) Areas of emphasis summary
- (k) Major contract milestone schedule - 90 Day lookahead
- (l) Component Sections (done at major element/organization/subsystem level):
  - Include all Summary Section items
  - Significant achievements
  - Pertinent next level performance/outcome based metrics (include any other yellow or red metrics)
  - Details of technical, cost and schedule risks and opportunities
- (m) Total contract planning assumptions for budget horizon estimates (5 years) (e.g., assumed launch sequence of Constellation elements), work content summary, workload drivers
- (n) Cost and workforce estimates through the budget horizon (5 years) (updates to work packages or their planning packages)
- (o) Major project milestone schedule - 5 Year lookahead (updated as required)
- (p) Life cycle cost analysis update since last major design review
- (q) Summary risks and opportunities (unique to the project, the budget for the extended horizon)

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE:** Contractor-proposed changes to the Performance Assessment Plan shall be submitted to NASA for approval. Complete re-issue of the document is required. The plan, including metrics, shall be reviewed annually and updated as required. Metrics shall be evaluated, updated and reported on a monthly basis on the web. Performance Management Review data packages shall be updated for monthly and quarterly Performance Management Reviews. Performance Assessment Reports shall be reported in formal quarterly and semiannual evaluation deliveries for the Performance Evaluation Board.



**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-M-003
3. **DATA TYPE:** 1
4. **DATE REVISED:** 12/6/2005
5. **PAGE:** 1
6. **TITLE:** Configuration Management Plan and Reports
7. **DESCRIPTION/USE:**  
To describe the Contractor's method for accomplishing the configuration management requirements of the contract. This will assure that a process will be used to appropriately and accurately define the configuration baselines of the contractor-provided products.
8. **DISTRIBUTION:** As Determined by the Contracting Officer
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
Configuration Management Plan is Type 1, Configuration Management Reports are Type 3.  
The following document(s) may be used as guidance:
  - MIL-HDBK-61A: Military Handbook Configuration Management Guidance
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 1 1.4  
Related DRD(s): CEV-T-006
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Configuration Management Plan (CMP) provides the Contractor's approach for implementation of configuration management in accordance with the SOW. The Contractor may combine this DR with the DRD CEV-T-006 Software Configuration Management Plan. If the Contractor chooses to combine the documents, the Contractor shall meet the requirements of both DRs.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The Configuration Management Plan shall define the scope and depth of the Contractor's efforts including management, organization, planning, and the relationship of the configuration management program to the Contractor's other administrative and technical organizations. The plan shall specify the Contractor's management policies and identify, by specific reference, standard practices and detailed work instructions to be used in implementing the configuration management program. The CMP shall provide the information defined in MIL-HDBK-61A. The plan shall include a preliminary data submittal schedule for fulfilling submission of data in the specific quantities, media, and due dates required. It will also discuss how the Contractor shall verify and validate their CM system through an internal audit process. The plan shall describe how the Contractor implements configuration management using their interface to the Exploration Systems Mission Directorate (ESMD) Integrated Collaborative Environment (ICE).

The Contractor shall use the ESMD Integrated Collaborative Environment

## Crew Exploration Vehicle -- (CEV)

(ICE) as defined in Attachment J-14 to implement the change flow process and to maintain the official project baseline files. The Contractor shall provide access to the native CM systems and data.

The Reports shall define the baseline of the delivered products capturing the 'as required,' 'as designed,' 'as tested,' 'as built' and 'as delivered' with a record of approved and implemented changes to the baseline. The reports shall contain references to change authorization and implementation documents.

13.4 **FORMAT:** Electronic format per Section J-2 2.3.2.1.

13.5 **MAINTENANCE:** Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-M-004
3. **DATA TYPE:** 1
4. **DATE REVISED:** 11/17/2005
5. **PAGE:** 1
6. **TITLE:** Data Management Plan
7. **DESCRIPTION/USE:**  
To describe the Contractor's plan for implementation of the data management requirements for the CEV Project. This will assure the Contractor's understanding of the process necessary to capture non-CM data relating to the project
8. **DISTRIBUTION:** As determined by the Contracting Officer
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 1.1.5.
13. **DATA PREPARATION INFORMATION:**
- 13.1 **SCOPE:**  
The Data Management Plan provides the Contractor's approach for implementation of data management in accordance with the SOW. The Contractor shall implement the ESMD Integrated Collaborative Environment interface as defined in J-14 to implement data management for the CEV Project.
- 13.2 **APPLICABLE DOCUMENTS:**
- 13.3 **CONTENTS:**  
The Data Management Plan shall define the scope and depth of the Contractor's efforts including management, organization, planning, and the relationship of the data management program to the Contractor's other administrative and technical organizations. The plan shall specify the Contractor's management policies and identify, by specific reference, standard practices and detailed work instructions to be used in implementing the data management program. The plan shall include the following elements: (1) data identification, (2) data control, (3) data status accounting, and (4) data management verification and audits, (5) data management organization, (6) data storage and retrieval procedures, (7) subcontractor procedures, and (8) special restrictions. The plan shall include a preliminary data submittal schedule for fulfilling submission of data in the specific quantities, media, and due dates required. The Contractor shall verify and validate their DM system through an internal audit process. The plan shall describe how the Contractor implements data management using their interface to the Exploration Systems Mission Directorate (ESMD) Integrated Collaborative Environment (ICE).  
  
The Contractor shall use the ESMD Integrated Collaborative Environment (ICE) as defined in Attachment J-14 to implement the data management flow process and to maintain the official project baseline files. The Contractor shall provide access to the native DM systems and data.

- 13 4 FORMAI: Electronic format per Section J-2 2.3.2.1.
- 13 5 MAINTENANCE: Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

**DATA REQUIREMENTS DESCRIPTION (DRD)**

1. **PROGRAM:** CEV
2. **DRD NO.:** CEV-M-005
3. **DATA TYPE:** 2/3\*
4. **DATE REVISED:** 12/20/2005
5. **PAGE:** 1
6. **TITLE:** Risk Management Plan and Reports
7. **DESCRIPTION/USE:**  
To provide the Contractor and the Government a baseline document for planning, management, control, and implementation of the Contractor's risk management program. To implement a risk management process that is consistent with the government provided guidelines. To develop and maintain risk management waterfall charts.
8. **DISTRIBUTION:** As determined by the Contracting Officer
9. **INITIAL SUBMISSION:** Per Data Requirements Matrix
10. **SUBMISSION FREQUENCY:** Per Data Requirements Matrix
11. **REMARKS:**  
\* The Risk Management Plan shall be data type 2. All other submissions are type 3.
12. **INTERRELATIONSHIP:** Parent SOW Paragraph(s): 1.1.6.  
Related DRD(s): CEV-S-001
13. **DATA PREPARATION INFORMATION:**
- 13.1. **SCOPE:**  
The Risk Management Plan addresses how NASA risk management requirements are to be implemented throughout the project's life cycle. The Risk Management Report provides a status of risks and risk mitigation plans and activities.
- 13.2. **APPLICABLE DOCUMENTS:**  
CXP-12000: NASA CEV Project Management Plan (PM-0001)
- 13.3. **CONTENTS:**  
The Risk Management Report shall contain the following data (Monthly):  
(a) Risk ID #, Risk Statement, Risk Context, Likelihood of Occurrence score and rationales, Consequence of Occurrence score (with cost, schedule, and technical rationale), and Timeframe Risk Consequence and Risk Likelihood shall be defined and scored consistent with the risk management requirements.  
(b) The Risk Waterfall chart for all high and medium rated risks. The Risk Waterfall chart is a graphical representation of the risk mitigation planning when a task plan is required.  
(c) Status of all risk mitigation plans and metrics.  
(d) Summary of risk mitigation activity and progress including objective evidence of exit criteria accomplishments.  
(e) Cost estimate, applicable schedule, and allocated resources for mitigation activity.  
(f) Documentation of contingency planning for risks that could not be successfully mitigated, accepted, or closed.  
(g) Summary of risk analyses.

## Crew Exploration Vehicle - (CEV)

Identified unfunded risks will contain the following data (Monthly):

(a) Risk ID#, Risk Statement, Risk Context, Likelihood of Occurrence score and rationales, Consequence of Occurrence score (with cost, schedule and technical rationale) and Timeframe. Risk Consequence and Risk Likelihood shall be defined and scored consistent with the risk management requirements. For Unfunded risks a Change

Request will be written containing the Contractor's proposal for mitigation, cost estimates and justification.

(b) Cost estimate, applicable schedule, and allocated resources for mitigation activity.

(c) Documentation of contingency planning.

(d) Integrated prioritized risk listing (including funded and unfunded risks) based on System needs.

The Contractor shall use a database tool compatible with the Integrated Collaborative Environment (ICE) Active Risk Manager Database to track identification and treatment of risks. If the ICE Active Risk Manager Database itself is not utilized, then the Contractor database shall be capable of exporting all required risk data to an Excel-based flat ICE Active Risk Manager database format file compatible with the ICE Active Risk Manager Database and delivered monthly with the risk management report.

#### WATERFALL CHART FEATURES

The plot of Risk Level vs Calendar Time will be divided into three colored areas:

Risk Exposure Level	Color
High	= Red
Moderate	= Yellow
Low	= Green

Determination of risk level is the qualitative combination of the likelihood of occurrence and the consequences of occurrence. The steps on the waterfall chart (Activities) are called gates. When a gate is completed, a downward step in Risk Level is achieved. As progress is made in completing the risk reduction plan, the line showing Risk Level is thickened to the point in time where activities have been completed. The chart will also contain the following features:

- (a) Gates will be denoted with activity numbers.
- (b) The chart will contain labels for the activities and exit criteria
- (c) The three colored areas are labeled High, Moderate, and Low.
- (d) The risk identification title is at the top of the page.
- (e) The risk file name and date of last update are shown in the bottom right corner
- (f) Project milestones such as major tests and project and applicable program reviews are placed along the Calendar time axis.

If gate completion is delayed, and the completion date is not known, the risk level line is extended past the step to the current point in time.

If an activity completion date changes, the original plan will be shown as a dashed line and the new plan denoted with a solid line. Activity numbers should be shown on both the original and new steps on the waterfall chart.

#### RISK RECOVERY PLAN

The risk recovery plan describes actions to be taken if activities in the risk reduction plan on the waterfall chart are not successfully completed. Recovery actions should be outlined for all gates, but at a

minimum, they should be completed for any gate associated with a change in Technical Risk Level from High to Moderate or Moderate to Low and for gates associated with important testing. This plan will be attached to the waterfall chart and will contain the following features:

- (a) Risk title.
- (b) Gate numbers.
- (c) Activities names.
- (d) Exit criteria associated with the activities.
- (e) Actual and planned activity completion dates.
- (f) Recovery plan for the gate. If the gate is completed successfully, the recovery actions are removed from the chart. For completed activities, which required some or all of the recovery actions, those actions should remain on the chart.
- (g) Recovery plan activities outside of the project's scope should be flagged.
- (h) The appropriate proprietary markings are placed at the top and bottom of the chart.

13.4 **FORMAT:** Electronic format per Section J-2.2.3.2.1.

13.5 **MAINTENANCE:** Contractor-proposed changes to document shall be submitted to NASA for approval. Complete re-issue of the document is required.

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SWRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-B-001	Financial Management Report (533)	3		I 30 Days After										U	The initial (baseline) NF533Q report shall be submitted within 30 days after authorization to proceed. In addition, NF533 reporting shall begin no later than 30 days after the incurrence of cost. Submission frequency is monthly for NF533M and Quarterly for NF533Q.
CEV-B-002	Workforce Reporting	3		I 30 Days After										U	The initial report shall be submitted within 30 days after authorization to proceed. Submission frequency is Quarterly for the first year, and Annually thereafter. Submission shall be by the twelfth working day of the month following the month end.
CEV-B-003	Cost Performance Report	2	I		F 30 Days Prior									U	Proposal submission shall be the IMS portion only, per instructions in Section L. Initial CPR submission shall be 30 days prior to IBR. Monthly CPR submission shall be by 10 to 12 working days of the month following the month being reported. Significant EVM system changes shall be submitted within 5 working days of such change.



DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SwRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-B-004	Property Financial Reporting	2		I										U	<p>The due date for the first Monthly Property Financial Reporting submission is the 21st day after the close of the month, beginning at the first month after contract start. Subsequent monthly reports shall be due the 21st day after the end of the month; for example, August 21 for the month ending July 31.</p> <p>The due date for the first Annual Property Reporting via NASA Form (NF) 1018 is November 30. Subsequent annual reports shall always be due on November 30.</p>
CEV-D-001	Flight Test Article (FTA) Definition	2	I		F 30 Days Prior										
CEV-D-002	Flight Test Article (FTA) System Requirements	1				F 45 Days Prior									
CEV-D-003	<del>XXXXXXXXXX</del> <del>XXXXXXXXXX</del>	1				F 45 Days Prior									
CEV-D-004	Flight Test Article (FTA) Engineering Design Data Book	2				I 45 Days Prior			U 45 Days Prior		U 45 Days Prior	F 45 Days Prior			

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SwRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-D-005	Flight Test Article (FTA) Validation and Verification Data Book	1										F 45 Days Prior			
CEV-D-006	Flight Test Article (FTA) Ground Support Equipment (GSE) Design Data Book	2				I 45 Days Prior			U 45 Days Prior			F 45 Days Prior			
CEV-M-001	CEV Prime Project Management Plan	3	I	F 30 Days After										U	Updates as required. In the event of changes due to streamlining plan efforts or significant changes in key personnel or in the reporting structure, an update shall be submitted within 5 working days of such change.
CEV-M-002	Performance Assessment Plan, Reports and Management Reviews	1/3 /3 *	I	U 45 Days After	F									U	Performance Assessment Plan delivery shall be at first IBR. The first Monthly input should support a review 20 working days after the initial financial month end. The first Quarterly input should support a review 20 working days after the end of the initial GFY quarter under contract. Submission frequency is Monthly and Quarterly.  * Plan= Type 1, Reports=Type 3, Review Packages=Type 3
CEV-M-003	Configuration Management Plan and Reports	1		I 45 Days After	F									U	Initial submission is ATP + 45 days; update as necessary to incorporate changes.

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SWRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-M-004	Data Management Plan	1		I 45 Days After	F									U	Initial submission is ATP + 45 days; update as necessary to incorporate changes.
CEV-M-005	Risk Management Plan and Reports	2/3 *		I 30 Days After	F									U	<p>The RM Plan initial submittal shall be submitted for approval within 30 days after contract start.</p> <p>Frequency Of Submission: The RM Plan shall be reviewed at least annually thereafter and updated as required. Additional Submissions: If there are no changes since the last update, the Contractor shall re-certify its accuracy NLT 1 October of each year.</p> <p>Monthly risk management reports shall be submitted showing the status of all risk management/risk mitigation efforts. The report shall highlight new risks that have been added since the last month as well as the up to date status of all "high" &amp; "medium" risks.</p>
CEV-O-001	Contractor's CEV Concept of Operations	2	I			U 45 Days Prior			U 45 Days Prior		F 45 Days Prior				
CEV-O-002	Flight Hardware/Software Operations and Maintenance Requirements Development Plan and Requirements Document	2				I 45 Days Prior		I 45 Days Prior	F 45 Days Prior	F 45 Days Prior				U	<p>Requirements Development Plan: Initial delivery @SDR, Final @ PDR.</p> <p>Requirements Document: Initial delivery @ SS PDR, Final @ SS CDR.</p> <p>Update Requirements Document as required.</p>

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SWRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-O-003	Launch Site Support Requirements Documentation	3							I 45 Days Prior		F 45 Days Prior	U 45 Days Prior			
CEV-O-004	CEV Operations Data Book	1				I 45 Days Prior		U 45 Days Prior		F 45 Days Prior				U	Update as required after baseline. Initial submission shall consist of outline of data to be provided.
CEV-O-005	Flight Operations Procedures Data	2							I 45 Days Prior		F 45 Days Prior			U	Update required @ L-18 months RRF-1. Update required @ L-18 months from 1st manned flight. Update required @ L-12 months from 1st manned flight. Initial submission shall consist of outline of data to be provided.
CEV-O-006	CEV Stowage Capabilities and Services Handbook	2				I 45 Days Prior			U 45 Days Prior		F 45 Days Prior			U	Update as required after baseline.
CEV-O-007	Range Safety Requirements Documents	1				I 45 Days Prior			U 45 Days Prior		F 45 Days Prior			U	Updates required to support LAS and RRF test flight key milestones
CEV-O-008	Ground Systems Requirements, Plans, Reports and Design Data	2/3		I 45 Days After		U 45 Days Prior			U 45 Days Prior		F 45 Days Prior				Reports are Type 3; all other deliveries are Type 2

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SWRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-S-001	Safety and Mission Assurance (S&MA) Plan	1	I	U 15 Days After		F 15 Days Prior									Proposal – deliver high level plan and schedule of DR deliveries.
CEV-S-002	Fault Tree Analysis	1				I			U 45 Days Prior		F 45 Days Prior				
CEV-S-003	System Safety Hazard Analyses	1				I			U 45 Days Prior		U 45 Days Prior		U 45 Days Prior		
CEV-S-004	Mishap Plan and Safety Statistics	2		I 15 Days After		U 15 Days Prior									The contractor shall provide monthly reports documenting monthly mishaps and safety statistics starting with contract approval.
CEV-S-005	CEV Ground Processing Certification Report	1				I 45 Days Prior			U 45 Days Prior		F 45 Days Prior				
CEV-S-006	Hazardous, Key Operations List	1				I			U 45 Days Prior		F 45 Days Prior				
CEV-S-007	Orbital Debris Assessment	1				I			U 45 Days Prior		F 45 Days Prior				

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SWRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-S-008	Safety and Health Plan	1	I	F											The contractor may revise the plan at any time or at the direction of the Government. Revisions are subject to Government review and approval. Distributions of approved revisions will be as described above.
CEV-S-009	Failure Modes Effects Analysis & Critical Items List (FMEA/CIL)	1/3				I			U 45 Days Prior		F 45 Days Prior			U	Update as required after baseline.
CEV-S-010	Probabilistic Risk Assessment Results	1				I 30 Days Prior			U 90 Days Prior		U 90 Days Prior		F 90 Days Prior		
CEV-S-011	Reliability, Maintainability, and Supportability Integrated Report	1				I		U 30 Days Prior	U 45 Days Prior		U 45 Days Prior		F 45 Days Prior		Initial draft with SDR, providing high-level system allocations.
CEV-S-012	Government-Industry Data Exchange Program and NASA Advisories/ALERTS	1/2												I	GIDEP, NASA Advisories, and Alerts shall begin with the manufacturing of flight or flight like hardware and software.
CEV-S-013	Problem Reporting and Corrective Action (PRACA) Reports	1/2 1/3*							I					U	PRACA reporting begins with the manufacturing of flight or flight like hardware and software.  *Data Type Initial Report is Data Type 2. Preliminary Report is Data Type 3. Close-Out/Explanation is Data Type 1.

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SwRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-S-014	Quality Assurance (QA) Audit Report	2				I 45 Days Prior								U	Submit every 6 months after hardware development begins.
CEV-S-015	Critical Processes	1				I 45 Days Prior			U 45 Days Prior		F 45 Days Prior				
CEV-S-016	Mechanical Parts Management and Implementation Plan	2				I 45 Days Prior			U 45 Days Prior		F 45 Days Prior				
CEV-S-017	Workmanship Standards	1							I		F 45 Days Prior				
CEV-S-018	Software Quality Assurance (SQA) Audit Report	3					I 45 Days Prior							U	Submission frequency is every 6 months after software development starts and through all software development and testing. A summary report of previous audits will be presented at the Software Requirements Review (SwRR).
CEV-T-001	Integrated Models, Simulations and Support Plan	2				I 45 Days Prior		U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	U 45 Days Prior			U	Initial submission will contain Modeling & Simulation Support Plan, an initial system architecture model, and discrete-event simulations. The addition of HLA federate deliveries will start at Subsystem PDR and continue thereafter.

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SWRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-002	CEV Engineering Models	2				I 45 Days Prior		U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	U 45 Days Prior			U	
CEV-T-003	CEV CAD Models	2	I			U 45 Days Prior		U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	F 45 Days Prior			U	Final delivery of completed as-designed models at AR supplemented with documentation of as-built discrepancies. Other = DCR
CEV-T-004	CEV Drawings	3						I 45 Days Prior	U 45 Days Prior	U 45 Days Prior	F 45 Days Prior			U	Maintained as-built
CEV-T-005	Software Development Plan	2	I			F 45 Days Prior									
CEV-T-006	Software Configuration Management Plan	2				F 45 Days Prior									
CEV-T-007	Software Development Folder	5													
CEV-T-008	CEV System Analysis Plan	2	I			U 45 Days Prior									



DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SwRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-009	CEV Analysis Reports	3												U	To be provided within 15 business days of the completion of each analysis cycle. Each analysis cycle ranges in duration from 4 to 6 months.
CEV-T-010	System Performance Analysis Report	3												U	To be provided within 15 business days of the completion of each analysis cycle. Each analysis cycle ranges in durations from 4 to 6 months.
CEV-T-011	Integrated Logistics Support Plan	2	I			U 45 Days Prior			U 45 Days Prior		U 45 Days Prior	F			Final submission 90 days prior to initial hardware delivery
CEV-T-012	Logistics Support Analysis	2				I 45 Days Prior			U 45 Days Prior		U 45 Days Prior	F			Final submission 90 days prior to initial hardware delivery
CEV-T-013	Launch Site CEV Propellants, Fluids, and Gases Forecast	3							I 45 Days Prior		U 45 Days Prior			U	Annual updates for the term of the contract.
CEV-T-014	Supportability Data Package	2				I 45 Days Prior			U 45 Days Prior		U 45 Days Prior	F			Final submission 90 days prior to initial hardware delivery
CEV-T-015	Master Verification Plan (MVP)	1				I 45 Days Prior		U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	F 45 Days Prior				

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SWRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-016	Certification Plans	2							I 45 Days Prior		F 45 Days Prior				Initial at PDR for the equipment or facility it addresses. Final at CDR for the equipment or facility it addresses.
CEV-T-017	Certification Data Package	1										F 45 Days Prior		F	Certification Data Packages shall be completed at the spacecraft, module, subsystem, and component levels. Certification reviews shall be held at each level.
CEV-T-018	Certification Approval Request	1										F 45 Days Prior		F	Certification Approval Requests shall be completed at the spacecraft, module, subsystem, and component levels. Certification reviews shall be held at each level.
CEV-T-019	Materials and Processes Selection, Implementation, and Control Plan	2				F 45 Days Prior									Contractor-proposed changes to document may be submitted to NASA for approval at any time after final approval. Complete re-issue of the document is required.
CEV-T-020	Materials Usage Agreements (MUA)	1/2							I 45 Days Prior		F 45 Days Prior				Although the vast majority of MUAs will be identified after PDR, the contractor shall identify and provide preliminary MUAs at PDR for major materials and processes applications that are essential to the planned vehicle design, but would require an approved MUA.
CEV-T-021	Contamination Control Plan (CCP)	2							I 45 Days Prior		F 45 Days Prior				

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SwRFR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-022	Materials Identification and Usage List (MIUL)	2							I 45 Days Prior		F 45 Days Prior				
CEV-T-023	Nondestructive Evaluation Plan	2							I 45 Days Prior		F 45 Days Prior				
CEV-T-024	Corona Design Criteria	2				I 45 Days Prior			F 45 Days Prior						
CEV-T-025	CEV Electromagnetic Compatibility Control and Verification Document	1				I 45 Days Prior			U 45 Days Prior		U 45 Days Prior			U	Section 1 Final at SDR Section 2 Final at PDR; Updates as required. Section 3 Final at PDR; Updates as required. Section 4 Final at PDR; Updates as required. Section 5 Final at SDR; Updates as required. Section 6 Final at SDR; Updates as required. Section 7 Final at SDR for plans; Final 2 months after completion of verification activities for LPVR

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SWRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-026	Spectrum Management Documents	1		I 45 Days After					U 45 Days Prior		F 45 Days Prior			U	Forms NTIA-33 - Transmitter Equipment Characteristics, NTIA-34 -Receiver Equipment Characteristics, & NTIA-35 -Antenna Equipment Characteristics shall be completed by the contractor for each RF system for operational vehicle.  Spectrum Management documents: Stage 1 Forms shall be delivered at ATP + 45 days. Stage 2 Forms shall be delivered at PDR. Further stages finalized at CDR.  Update as required after baseline.
CEV-T-027	Electrical, Electronic, and Electromechanical Parts Management and Implementation Plan	1				F 45 Days Prior									
CEV-T-028	As-Built EEE Parts List	3												U	The As-Built EEE Parts List shall be submitted with each acceptance data package

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SwRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-029	Interface Control Documents	1												U	<p>External ICDs will be: Initial at subsystem PDR Update at PDR Update at subsystem CDR Final at CDR</p> <p>Internal ICDs will be: Module ICDs: Initial at subsystem PDR Update at PDR Update at subsystem CDR Final at CDR</p> <p>Subsystem ICDs: Initial at subsystem PDR Update at PDR Update at subsystem CDR Final at CDR</p> <p>Software Interface Design Description Documents: Initial at PDR Update at subsystem CDR Final at CDR</p> <p>All levels: update as required after baseline</p>

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SwRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-030	CEV/Constellation Integrated Assessment Document	2				I 45 Days Prior			U 45 Days Prior		U 45 Days Prior			U	To be provided within 15 business days of the completion of each analysis cycle. Each analysis cycle ranges in durations from 4 to 6 months. Note: The results of this DRD along with the supporting data will be used to support Constellation Integration Reviews. Prior to PDR the Integration Reviews will be phased with the CEV major project reviews (i.e. Contractor SDR, & PDR). Post PDR, Integration Reviews will occur yearly and will be scheduled per Contracting Officer Letter.
CEV-T-031	CEV <Level> Requirements Specification	1/3 *												I	<p>System-level Requirements Specifications: Final 45 days prior to SDR</p> <p>Module-level Requirements Specifications: Final 45 days prior to SDR</p> <p>Subsystem-level Requirements Specifications: Initial 45 days prior to SDR Final 45 days prior to SSPDR</p> <p>Component-level Requirements Specifications: Initial 45 days prior to SSPDR Final 45 days prior to PDR</p> <p>All levels: Update as required after baseline.</p> <p>*System-level, Module-level, and Subsystem-level Requirements Specifications are type 1 documents. Component-level Requirements Specifications are type 3 documents.</p>

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SwRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-032	CEV Specification and Drawing Trees	1				I 45 Days Prior			F 45 Days Prior		U 45 Days Prior			U	Update as required after baseline.
CEV-T-033	Architecture Design Document	2				F 45 Days Prior								U	Contractor's option to maintain post-SDR.
CEV-T-034	Requirements Traceability Report	1												U	The Requirements Traceability Matrix is due with each delivery of the requirements
CEV-T-035	Internal Interface Requirements Document (IRD)	1												U	<p>Module IRDs: Final at SDR</p> <p>Subsystem IRDs: Initial at SDR Final at Subsystem PDR</p> <p>Software Interface Requirements Specifications: Initial at SwRR Final at PDR</p> <p>All levels: update as required after baseline</p>

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SWRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-036	Margins Management Plan/Report	2/3 *				F 45 Days Prior								U	<p>This DRD consists of two products: a Margin Management Plan and monthly reports.</p> <p>The Margin Management Plan shall be submitted: Final at 45 days prior to SDR</p> <p>Margin Management Reports shall be submitted monthly and at each major review.</p>
CEV-T-037	Qualification Test Procedures	3								I 45 Days Prior				F	Final qualification test procedures for each test level due two weeks prior to each TRR.
CEV-T-038	Qualification Test Report	3												F	Each Qualification Test Report due two months following each qualification test completion.
CEV-T-039	Acceptance Test Procedures	2								I 45 Days Prior				F	Final acceptance test procedures for each test level due two weeks prior to each TRR.
CEV-T-040	Acceptance Data Package	1										F 45 Days Prior		F	Acceptance Data Packages shall be completed at the spacecraft, module, and component levels. Acceptance reviews shall be held at each level.
CEV-T-041	CEV Instrumentation Plan	2							F 45 Days Prior					U	Some parts of this DRD (e.g., the calibration provision, the ground data reduction process) may continue to evolve as the design maturing and will need to be updated after baseline.



DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SWRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-042	Mass Properties Control Plan	2				F 45 Days Prior									
CEV-T-043	Mass Properties Reports	3				I 45 Days Prior		U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	F 45 Days Prior	U	In addition to the formal deliveries at major project milestones, mass properties reports will be needed on a periodic and as-requested basis to support design and integration activities for the CEV Project and Constellation Program. Mass properties updates will be required throughout the life of the CEV Project for each production spacecraft by mission.
CEV-T-044	CEV MMOD Analysis Report	2						I 45 Days Prior	U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	F 45 Days Prior			
CEV-T-045	CEV Space Radiation Analysis and Certification Report	2				I 45 Days Prior		U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	U 45 Days Prior		F 45 Days Prior		Reports to be delivered at major project milestones and as needed for the design and integration of the CEV System and the integration of Constellation Program elements.
CEV-T-046	CEV Data and Command Dictionary	1						I 45 Days Prior	U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	F 45 Days Prior	U	Living document maintained throughout design and operation.
CEV-T-047	Avionics Design and Data Book	3						I 45 Days Prior		U 45 Days Prior		F 45 Days Prior	U 45 Days Prior		

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SWRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-048	Software Requirements Specification	1					I 45 Days Prior		F 45 Days Prior					U	All levels: update as required after baseline
CEV-T-049	Monthly Software Metrics Report	3					I							U	Other = Monthly after the initial submission at SWRR.
CEV-T-050	Software Design Description	2							I 45 Days Prior	U 45 Days Prior	F 45 Days Prior			U	All levels: update as required after baseline
CEV-T-051	Software Inspection and Peer Review Report	5												U	Other = All submissions should be accessible 10 working days after each inspection.
CEV-T-052	Software Test Plan	2							I 45 Days Prior	F 45 Days Prior				U	All levels: update as required after baseline
CEV-T-053	Software Test Description	2							I 45 Days Prior	F 45 Days Prior				U	All levels: update as required after baseline
CEV-T-054	Software Test Report	2									I 45 Days Prior	F 45 Days Prior			

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SwRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-055	Software Maintenance Plan	2							I 45 Days Prior		F 45 Days Prior				
CEV-T-056	Software User Manual	2									I 45 Days Prior	F 45 Days Prior			
CEV-T-057	Software Version Description Document	3									I 45 Days Prior			U/F	Updated/new with each software delivery.
CEV-T-058	Radio Frequency/Optical ICDs	1				I 45 Days Prior			U 45 Days Prior		F 45 Days Prior			U	Update as required after baseline.
CEV-T-059	Electrical Power System (EPS) Design and Data Book	3						I 45 Days Prior		U 45 Days Prior		F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books.
CEV-T-060	Electrical Power Quality Specification Requirements Document	1				F 45 Days Prior									

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SWRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-061	Mechanical Systems Design and Data Book	3						I 45 Days Prior		U 45 Days Prior		F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books.
CEV-T-062	Stress Analysis Report	2						I 45 Days Prior	U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	F 45 Days Prior	U	At each subsystem PDR and CDR, the stress analysis deliverable is for each subsystem, not the whole vehicle.
CEV-T-063	Passive Thermal Control Design and Data Book (PTCDDDB)	3						I 45 Days Prior		U 45 Days Prior		F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books.
CEV-T-064	Passive Thermal Control Mathematical Models and Documentation	3				I 45 Days Prior		U 45 Days Prior		U 45 Days Prior		F 45 Days Prior			
CEV-T-065	Thermal Protection System Design and Data Book (TPSDDDB)	3						I 45 Days Prior		U 45 Days Prior		F 45 Days Prior	U 45 Days Prior		
CEV-T-066	Thermal Protection System Mathematical Models and Documentation	3				I 45 Days Prior		U 45 Days Prior		U 45 Days Prior		F 45 Days Prior			

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SWRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-067	Structural Loads Data Book	2							I 45 Days Prior		U 45 Days Prior	U 45 Days Prior	F 45 Days Prior		
CEV-T-068	Structures Mathematical Models and Documentation	3				I 45 Days Prior		U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	F 45 Days Prior		
CEV-T-069	Fracture Control Plan	2							F 45 Days Prior						
CEV-T-070	Fracture Control Summary Report	2								I 45 Days Prior	U 45 Days Prior	U 45 Days Prior	F 45 Days Prior		
CEV-T-071	Propulsion Systems Design and Data Book	3						I 45 Days Prior		U 45 Days Prior		F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books.
CEV-T-072	Suits, EVA and Survival Crew Equipment Support Systems Design and Data Book	3						I 45 Days Prior		U 45 Days Prior		F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books.

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			Proposal	ATP	IBR	SDR	SWRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-073	Environmental Control and Life Support Design and Data Book	3						I 45 Days Prior		U 45 Days Prior		F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books.
CEV-T-074	Habitation Accommodations Design and Data Book	3						I 45 Days Prior		U 45 Days Prior		F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books.
CEV-T-075	Pyrotechnic Subsystem Design and Data Book	3						I 45 Days Prior		U 45 Days Prior		F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books.
CEV-T-076	Recovery Systems Design and Data Book	3						I 45 Days Prior		U 45 Days Prior		F 45 Days Prior	U 45 Days Prior		Drop testing-related documentation to be delivered as addendum to databook during drop test program. Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books.
CEV-T-077	Recovery Systems Simulation Models and Documentation	3						I 45 Days Prior	U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	F 45 Days Prior		

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SwRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-078	GN&C Design and Data Book	3						I 45 Days Prior		U 45 Days Prior		F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books.
CEV-T-079	CEV Wiring Plan	2				F 45 Days Prior									
CEV-T-080	CEV Wiring Database and Reports	3						I 45 Days Prior	U 45 Days Prior	U 45 Days Prior	U 45 Days Prior	F 45 Days Prior		U	Database maintenance will be required throughout the life of the CEV Project. Reports will be provided as needed to status wiring progress and to support design and integration activities for the CEV System.
CEV-T-081	Launch Abort System Design and Data Book	3						I 45 Days Prior		U 45 Days Prior		F 45 Days Prior	U 45 Days Prior		Design and data books are intended to be living documents maintained throughout the design and development process. By acceptance review the design and data books should transition to operational data books.
CEV-T-082	Spacecraft Test & Verification Facility System Requirements Document	1				I 45 Days Prior			F 45 Days Prior						
CEV-T-083	Spacecraft Test & Verification Facility System Design Document	3							I 45 Days Prior		U 45 Days Prior	F 45 Days Prior			

DRD	Title	Type	Submission Events												Notes
			Proposal	ATP	IBR	SDR	SWRR	SubSys PDR	PDR	SubSys CDR	CDR	AR	FRR	Other	
CEV-T-084	Spacecraft Test & Verification Facility Certification Plan	2				I 45 Days Prior			F 45 Days Prior						
CEV-T-085	Spacecraft Test & Verification Facility Certification Package	1										F 45 Days Prior			Due 45 days prior to the vehicle acceptance review.
CEV-T-086	Manufacturing and Assembly Plan	2							I 45 Days Prior		F 45 Days Prior				
CEV-T-087	CEV Handling and Transportation Plan	2							I 45 Days Prior		F 45 Days Prior				
CEV-T-088	CEV Imagery Plan/Imagery Deliverables	2/3 *				F 45 Days Prior									CEV Imagery Plan - Final 45 days prior to SDR. CEV Imagery Deliverables - Imagery loaded to ICE as images are processed and categorized.